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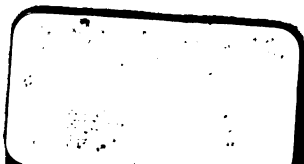
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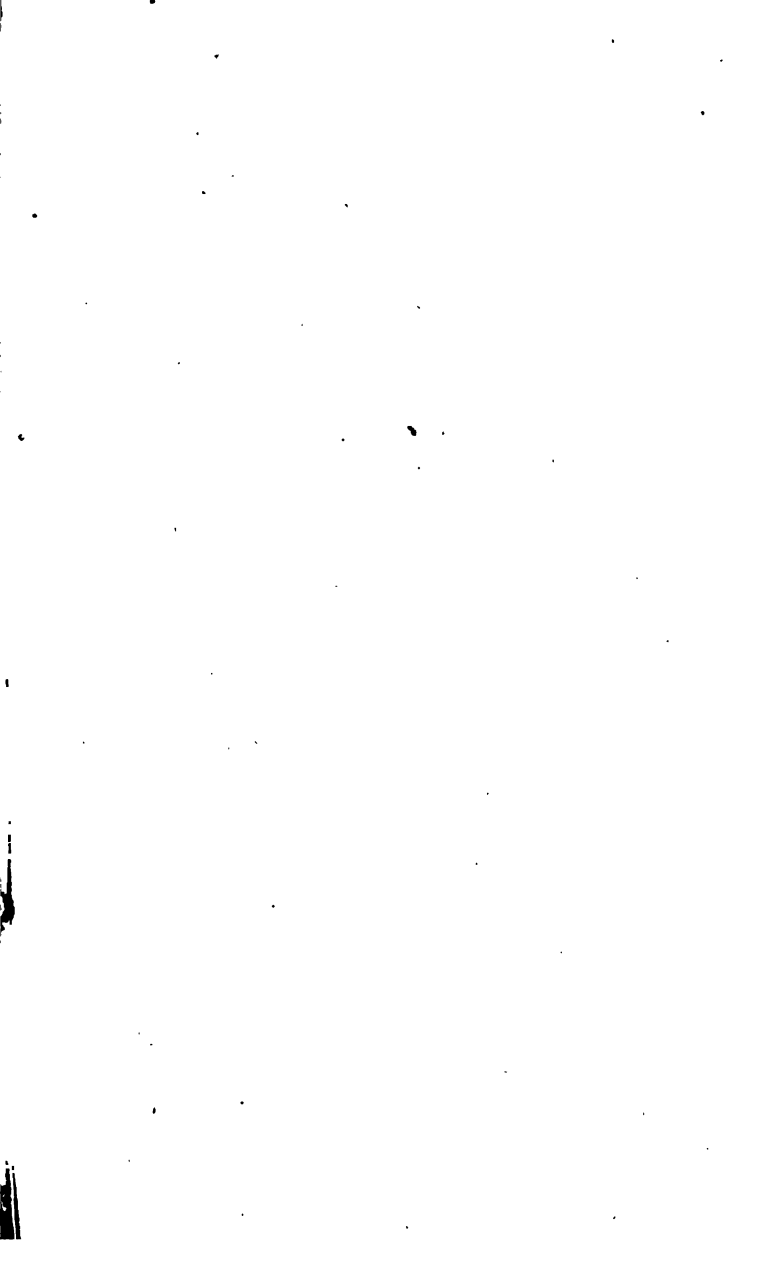
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**HARRY AND LUCY**

**CONCLUDED.**

**LONDON:**  
**PRINTED BY CHARLES WOOD,**  
**Poppin's Court, Fleet Street.**

# HARRY AND LUCY

CONCLUDED;

BEING THE

LAST PART OF EARLY LESSONS.

BY

MARIA EDGEWORTH.

IN FOUR VOLUMES.

VOL. I.

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The business of Education, in respect of knowledge, is not, as I think, to perfect a learner in all or any one of the sciences; but to give his mind that disposition, and those habits, that may enable him to attain any part of knowledge he shall stand in need of in the future course of his life.

LOCKE.

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SECOND EDITION, CORRECTED.

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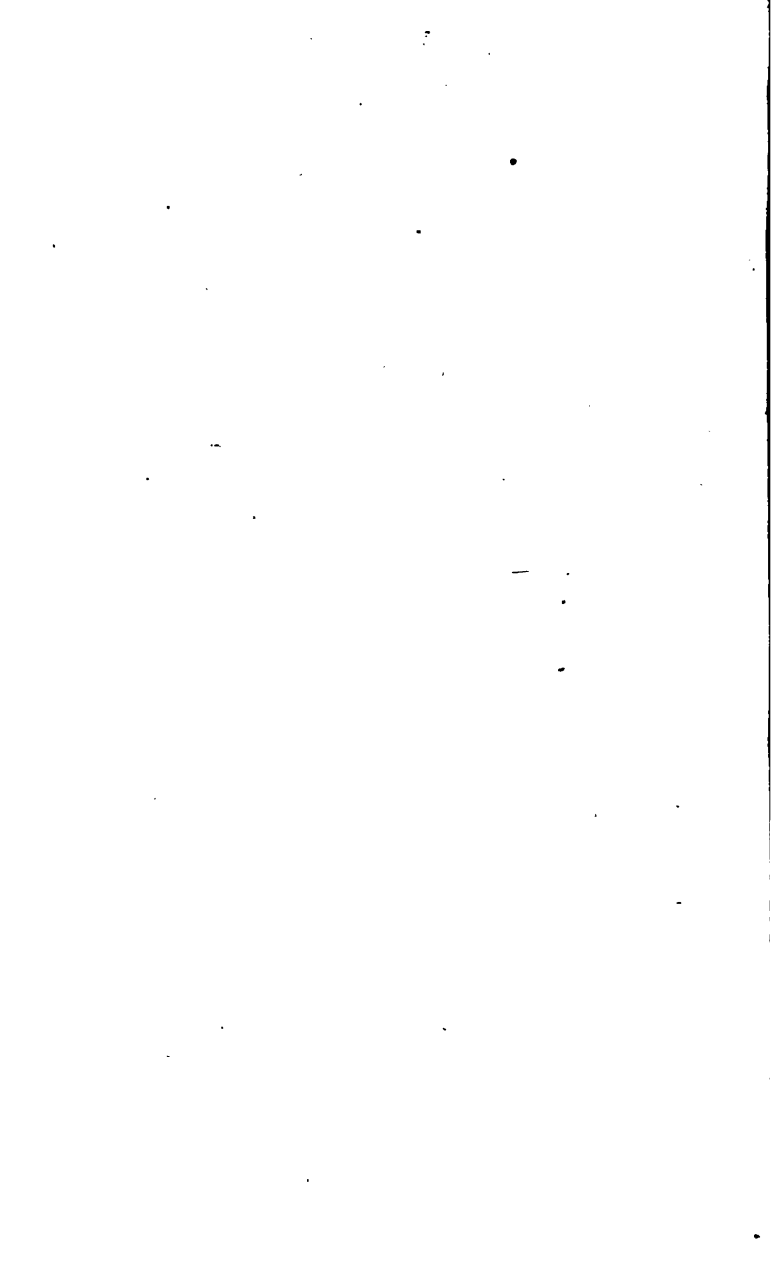


**LONDON:**  
**PRINTED BY CHARLES WOOD,**  
**Poppin's Court, Fleet Street.**

**TO**  
**THE CHILDREN OF**  
**HER FATHER'S FRIEND,**  
**CAPTAIN BEAUFORT,**

**THIS BOOK IS**  
**DEDICATED**

**BY**  
**MARIA EDGEWORTH.**



## PREFACE;

ADDRESSED TO PARENTS.

---

THESE volumes are intended for young people, from the age of ten to fourteen. They complete the series of "Early Lessons;" an humble work, from which no literary fame can be acquired, but which I have been most desirous to complete, from the belief that it will be more useful than any other in my power. I have had another motive for finishing it; one, which, though it may be no concern of the public, I may be permitted to name. Harry and Lucy was begun by my father, above fifty

years ago, for the use of his own family, and published at a time when no one of any literary character, excepting Dr. Watts and Mrs. Barbauld, had ever condescended to write for children. That little book was, I believe, the very first attempt to give any correct elementary knowledge or taste for science in a narrative suited to the comprehension of children, and calculated to amuse and interest, as well as to instruct. Finding, from experience, that it answered the intended purpose, my father continued the book at intervals; and in the last part, published in 1813, I had the pleasure of assisting him. He then communicated many ideas for the completion of his plan, which I thought too valuable to be abandoned. I considered, that a full knowledge of his views, and long habits of acquaintance with his mode of teaching, might enable me to do justice to his

plan, though I was aware of the difficulty of combining ingenious with practicable illustrations, and still more sensible of the accuracy requisite for elementary instruction. The want of his mind working along with my own, I knew must be in this attempt peculiarly felt; but I have been encouraged to persevere by the assistance afforded me by his and my own scientific friends. To name these kind and able friends would gratify my vanity, and might ensure the confidence of parents; but it would, perhaps, have more the appearance of ostentation than of candour, and might leave others responsible for errors, which have escaped the most careful revisal.

I have endeavoured to pursue, in this Conclusion of Early Lessons, my father's object in their commencement—to exercise the powers of attention, observation, reasoning, and invention, rather than to teach

any one science, or to make any advance beyond first principles. The essential point is to excite a thirst for knowledge, without which it is in vain to pour the full tide even to the lips. As Dr. Johnson said to Boswell, when he was describing the pains his preceptors had taken to give him learning —

“ Sir, anybody can bring a horse to the water, but who can make him drink ? ”

Consistently with the sort of instruction to be conveyed, it was impossible to give as much of the amusement arising from incident and story, in this book, as in some others. But the varying occurrences of domestic life, the frequent changes of scene, and the different characters of the children, with all their hopes and fears in the pursuit of their own little schemes and experiments, will, I hope, produce sufficient action to create interest, and to keep awake

attention. No pernicious stimulus has been given, no deception or cajolery employed to effect our purpose. All attempts to cheat children, by the false promise that they can obtain knowledge without labour, are vain and hurtful. The gods sell every thing to labour, and mortals, young or old, must pay that price. The wages of industry should, however, be rendered as certain as possible ; for the pupils will exert themselves in proportion to their hopes, that their efforts will be recompensed by the pleasure of success. I have taken all the precautions in my power to secure to each effort of attention its just reward.

Much that would be tiresome and insufferable to young people, if offered by preceptors in a didactic tone, will be eagerly accepted when suggested in conversation, especially in conversations be-



tween themselves : in these there is always a certain proportion of *nonsense* ; an alloy, which is necessary to make sense work well. Children can go on talking to one another much longer than they can bear to hear the address, however wise or eloquent, of any grown person. Young people, of good disposition, learn with peculiar ease from each other, because the young teacher has not forgotten his own difficulties : knowing exactly where they lay, he sees how to remove them, or to assist another over the obstacles. The great preceptor, standing on the top of the ladder of learning, can hardly stretch his hand down to the poor urchin at the bottom, looking up to him in despair ; but an intermediate companion, who is only a few steps above, can assist him with a helping hand, can show him where to put his foot safely ;

and now urging, now encouraging, can draw him up to any height within his own attainment.

The system of mutual instruction can be still more advantageously pursued in teaching the rudiments of science than those of literature, and may be extended even to higher branches of intellectual education. Upon this principle, in the following volumes, the young brother is employed to teach his sister what he has learned, either from his father, or from books.

Harry's abilities and knowledge will perhaps appear a little above his age; but this the reader must excuse, and attribute, as he pleases, to education, or to accident, or to natural genius. Harry will not be disliked because he is not pedantic; and he has some redeeming faults and foibles, which save him from the odium attached

to a perfect character, and from the danger of being thought too good to be natural.

Lucy, on the other hand, may at times seem too childish and volatile; her respect for accuracy not being at first much greater than that of the sailor, who said, "We'll not quarrel for a handful of degrees." But these faults produce the nonsense and the action necessary to relieve the reader's attention. As to the danger and the penalties of her becoming an affected scientific lady, it is left to her mother's and her own good sense and good taste to guard against that evil. All that can be said or thought upon the subject by the other sex, is comprised in the Edinburgh wit's declaration —

"I do not care how *blue* a lady's stockings may be, if her petticoats are but long enough."

My father long ago foresaw, what every-

body now feels, that the taste for scientific, as well as literary knowledge, which has risen rapidly, and has spread widely, would render it necessary to make some provision for the early instruction of youth in science, in addition to the great and successful attention paid to classical literature. In public establishments, alterations, even when felt to be requisite, must for many reasons be tardy; much, in the mean time, may be prepared by private instruction.

It has been feared by some, that the general diffusion of knowledge will tend to damp the energy of genius; and that original invention will decline, in consequence of increased cultivation. This might, perhaps, be the consequence of injudicious cultivation. If the acquisition of a great quantity of learning of all kinds, or of any kind, were made the sole and ultimate object, the mind would be op-

pressed, and invention extinguished under the mass: but of this there is no danger if the faculties be proportionably exercised, and if the pupil be enabled to arrange, and above all to employ his knowledge. In science, [the hope of future discoveries, and the ambition to invent, are great, natural, and never-failing excitements to young and old.

That very ingenious and very mysterious philosopher, Dr. Hooke, speaks somewhere in his works of an algebraic formula, by which he could determine what things are possible or impossible to perform or to invent. Without perfectly crediting or perfectly understanding this veiled prophet, we may hope and believe, that the inventive power may be assisted and improved by exercise, by reasoning, and by judicious experiments. Many admirable observations on the nature and conduct of the

understanding, on the causes which have prevented our advancement in knowledge, and on the habits of false reasoning, prepossessions, and prejudices, which enslave and disable our faculties, are to be found in the works of Bacon and of Hooke, of Locke, Stewart, and Playfair. These observations should not be suffered to lie dormant in books, the admiration only of the learned; nor should we be content with merely citing them occasionally, to adorn our writings, or to point our conversation. Metaphysics, after being too much in fashion, have been thrown aside too disdainfully, and their use and abuse have been confounded. Surely it would be doing good service to bring into popular form all that metaphysicians have discovered, which can be applied to practice in education. This was early and long my father's object. The art of teaching to in-

vent—I dare not say—but of awakening and assisting the inventive power by daily exercise and excitement, and by the application of philosophic principles to trivial occurrences, he believed might be pursued with infinite advantage to the rising generation.

I have now stated all the objects of this book: how far they have been accomplished must be left to time, and parents, and, above all, to children to decide.

MARIA EDGEWORTH.

*May 31st, 1825.*

# HARRY AND LUCY

CONCLUDED.

---

“MAMMA, do you recollect, two years ago, when my father was explaining to us the barometer and thermometer, and when he showed us several little experiments?” said Lucy, and she sighed.

“Yes, my dear, I remember that time very well,” said her mother; “but why do you sigh?”

“Because I was very happy *then*,” said Lucy.

“And are not you happy now, my dear?”

“Yes, mamma, but not so very happy as I was then, because now I do not *go on* with Harry as I used to do.”

“How so? I hope that you have not had any quarrel with your brother?”



“Quarrel! oh no, mamma, it would be impossible to quarrel with Harry, he is so good natured; and he is as fond of me as ever, I believe. But yet, I do not know how it is, we do not suit each other quite so well as we did. We are not so much together; I do not know all he is doing, nor go on with all he is thinking of, as I used to do.”

“My dear Lucy, you and your brother have been learning different things for some time past; and as you grow older, this must be; your different employments must separate you during a great part of the day; and so much the better, you will be the more glad to be together in your hours of amusement. Do not you find this?”

“Yes, I do, mamma,” said Lucy, “but—” and after this *but* she sighed again. “But now we are not amused always in the same way. Harry has grown so excessively fond of mechanics, and of all those

scientific things, which he is always learning from my uncle and papa."

"I thought, Lucy, that you were fond of those things too?" said her mother.

"So I am, mamma; only I am not nearly so fond of them as I was formerly: I do not exactly know why; but, in the first place, I suppose, because I do not understand them now nearly so well as Harry does: he has got very far before me."

"True," answered her mother, "you have been learning other things, which it is more necessary for a girl to know."

"Yes, mamma, I remember your saying just after that happy barometer time, that I thought of nothing but experiments; papa said, that must not be. Then I was not allowed to go into his room with Harry in the mornings. However, I learned more of arithmetic, and drawing, and dancing, and music, and work."

"And you grew fond of these; so much the better," said her mother. "This does not make you less happy, does it?"

"No, no, mamma; but then came the time when Harry and I were quite separated. That long—long—long time, when you were ill, mamma, and when I was at my aunt Pierrepont's: while I was with her, I read nothing but stories and poetry, and I heard my aunt and people who were there reading plays. She used to praise me for understanding wit, and for repeating poetry. Then I grew very fond of them. But Harry is so grave always about wit, he never understands it at first; and at last he says, 'Is that all?'—As to similes, they always interrupt him."

"*They* interrupt him!" said her mother, "perhaps, Lucy, *you* interrupt him."

"Sometimes, perhaps, I do, mamma; but he always finds out that similies are not exact. This is very provoking. I wonder why he is so much fonder of exactness than I am."

"Probably because in science, which he has been learning, he finds at every step the use, the necessity of exactness.

He could not go on without it in measuring or in reasoning."

"Mamma, I understand the use of exactness in some things. In drawing in perspective, and in proportion, by a scale, as you taught me. Harry came to me the other day, and asked me to draw a cart for him; and I was glad to find that I could help him in something."

"And I dare say he will be glad to help you in his turn. You each know different things, which you can learn from one another, and in which you can be of mutual assistance. This is just as it should be between friends."

"Thank you, mamma, you make me feel happy again. I will ask Harry to bring me up to him in all he has been learning, as fast as possible, that we may go on together as we used to do, if you have no objection, mamma."

"Do so, my dear Lucy; but I warn you, that you should not expect to go fast; you must be content to go slowly, and you must submit to be inferior to

your brother for some time. This may mortify you, my dear, but it cannot be avoided, you must bear it."

"Very well, mamma, I can bear it. But mother," said Lucy, hesitating a little; "there is one other thing I want to say, before I can be quite happy."

"Say it then, my dear: what are you afraid of?—Not of me, I hope?"

"Oh! no, mamma, not afraid of you; but I am not sure that the person, who said what I want to tell you, would like that you should know that he said it."

"You can tell me what was said, then, without telling me from whom you heard it. Cannot you, Lucy?"

"I can, and I will," said Lucy. "Then you must know, mamma, that one day, when I was at my aunt Pierrepont's, she was telling *somebody* that papa used to teach me scientific things, along with Harry; but that, since I had come to her, I had not learned any thing of that sort. And—now it comes, mamma, the gentleman, who is not to be named, laughed."

“ Well, there was no great harm in that.”

“ No, mamma; only that he laughed in a particular sort of way, scornfully. And he said, that it was well for me I had left off such *learning*. That I should be a much more agreeable woman without it; that ladies had nothing to do with science, or ought to have nothing to do with it. He said, that scientific ladies are always displaying what they know, or what they do not know. Those were his very words. He said, that scientific ladies were his *abhorrence*. And he looked as if he abhorred them terribly. I was very sorry at the time, that he knew papa had taught me any thing along with Harry. I was ashamed and frightened, and I thought it was all wrong. But now that I am come home I think, that it was all right; for I see how much papa likes that you should know the scientific things that he is busy about, and how happy it makes you; and I want to go on again with Harry: only

I wish, mamma, that all people were of the same opinions about *this*."

Her mother smiled, and said, "That can never be, my dear Lucy: you will find many people have different opinions upon this subject. But all will agree with your nameless gentleman, that when women pretend to understand what they do not, whether about science or any thing else, they are absurd and ridiculous. And if they talk even of what they understand, merely to display their knowledge, they must be troublesome and disagreeable. Therefore they should take care not to do so. They should be particularly cautious of talking on scientific subjects, because they seldom obtain accurate knowledge; they are, therefore, likely to make mistakes, and to be either troublesome in asking questions, or ridiculous in showing ignorance and conceit."

"That is," said Lucy, "if they *set up* for being scientific ladies."

"Yes, if they do that, they must take

the consequences, they will be disliked," said her mother.

"But then, mamma, I am so much afraid of being abhorred. Even if they are not conceited, will they be abhorred, mamma?"

"Not by persons of sense, my dear," said her mother. "As far as I can judge, I think that sensible men would be ready to assist any unaffected, unassuming woman, who really wished to inform herself, and would like her the better for being interested in their conversation, their writings, and their pursuits."

"I hope then, mamma, that I shall be an unaffected, unassuming woman."

"I hope so, my dear child," said her mother. "If your father did not hope so too, he would never teach you any more on these subjects."

"I should be very sorry for that," said Lucy.

"Yes, I think you would, my dear; for, even with your little experience, you



feel that there is a real pleasure in going on, as you say, with your brother."

"That I do, indeed, mamma."

"As you grow older," continued her mother, "you will perceive, that, by acquiring knowledge, women not only increase their power of being agreeable companions to their fathers, brothers, husbands, or friends, if they are so happy as to be connected with sensible men, but they increase their own pleasure in reading and hearing of scientific experiments and discoveries; they acquire a greater variety of means of employing themselves independently, and at home. But, above all, the acquisition of knowledge not only enlarges but elevates the mind, by filling it with admiration and gratitude towards that bountiful Providence who has established such wise laws for the welfare and preservation of the world."

"Yes, mother," said Lucy; and, after a pause, in which she re-considered all her

mother had been saying, she returned to what still a little alarmed her imagination. "But yet, mamma, I feel afraid of being *abhorred*; and if the acquiring knowledge should make me vain — there is the danger."

"There is the danger to be sure," said her mother. "But, as far as I have observed, ignorant women are as vain, and often more so, than those who are well informed; and now, when almost all are so educated that they have a taste for literature, and some acquaintance with scientific subjects, there is less danger that any should be vain, of what is no peculiar distinction."

"Oh, mother, I will take the greatest care," said Lucy; "you shall see as I grow up; and thank you for explaining all this to me."

"Perhaps, my dear, part of what I have been saying is rather above your comprehension?"

"No, mamma; not at all. If it is not conceited to say so, I think I understand

it all perfectly well ; and now I know what is right and wrong, and my mind is settled ; and I am happy gain, and very glad that I may have the pleasure of learning again from papa ; and, above all, glad that I may *go on again* with Harry. And here he comes, mamma ; I see him from this window, coming along the path from my uncle's. Oh, mamma ! he has a great walking stick in his hand, and he is hobbling like an old man of an hundred and ten."

" I hope he has not hurt himself," said her mother, coming to the window.

" No, mamma, I believe he is only in play. There ! the old man is running as well as ever he did in his life ; and I will run and meet him."

As soon as Lucy was near enough to make her voice heard, she asked her brother why he walked with his uncle's walking stick ? as she supposed it to be.

" It is not his," said Harry, " it is mine ; my uncle has given it to me."

"Yours! and it is quite new; I never saw it before. How beautifully varnished! and what a pretty head! But why did my uncle give it to you, Harry? It would be of use to him, and it will be of none to you," said Lucy.

"There you are mistaken; I beg your pardon, Lucy. It will be of as much use to me as it would be to him, and of the same sort of use," said Harry.

"Same sort of use!" said Lucy; "but of what sort?"

"Guess," said Harry.

"I suppose you mean in play, to act an old man, as you did just now?"

"No, in earnest useful," said Harry.

"What *can* you do with it?" said Lucy  
"for you are too young to walk with it, and too old to ride upon it."

"Too old! to be sure I am," said Harry, indignantly; "I have not ridden upon a stick these hundred years. Guess again."

Lucy now wanted to examine this wonderful stick more closely, in hopes of dis-

covering what its merits might be, but Harry seemed unwilling to let it out of his hands.

“ Oh ! I know what it is. It is full of money. It is like the staff which the man had in the trial in Don Quixote, which Sancho Panza found out was full of money, because he would not let it out of his hands.”

“ I do not in the least know what you mean,” said Harry, “ for there is no money in this.”

“ Then let me look at it ; I will not run away with it. How heavy it is,” observed Lucy, “ what wood can it be made of?—This outside seems to be mahogany, but I never felt any so heavy. It cannot be all wood ; it must be hollow, and there must be something withinside of it.”

“ Stop ! stop ! do not shake it ; do not turn it upside down ; you will spoil it,” cried Harry.

“ Ho ! ho ! then there is something withinside of it. I have found that much out,” said Lucy ; and you say, ‘ Do not turn

it upside down,' like the words on the box of glass that came last week; '*Keep this side uppermost.*' So I guess that there is glass within your stick. You smile, there is! Glass!—Then perhaps it is a spy-glass—a telescope?—a magnifying glass?—a microscope? No, none of these? What can it be? Of what use can glass be in a walking stick, Harry?"

"Of a great deal, as you will acknowledge when you find it out. Guess again," said Harry; "it is a thing that you have seen."

"But I have seen so many things," said Lucy.

"And of which you know the use," said Harry.

"But I know the use of many things! Tell me a little more," said Lucy; "what is it used for?"

"For weighing *something*," said Harry; "stay, I am not sure that it is quite fair to say it is used for weighing a *thing*, and yet it is something."

"I know now," said Lucy; "that mo-

tion you made with your hand up and down against the air, told me. The *something* that it is used for weighing is air, and it is a barometer."

"Now you have found it out," said Harry.

"And now I know what makes your stick so heavy," said Lucy. "The quicksilver—the mercury. I remember feeling the weight of mercury, when papa put into my hands two cups of the same size, one full of water, and the other full of mercury. How stupid I was not to think of this at first, and not to guess it was a barometer!"

Harry now showed where his walking stick opened, and he showed her within-side of it a barometer and thermometer; he explained to her how the quicksilver was screwed up tight, so as to prevent it from shaking. He told her this was called a portable barometer.

"Yes, it is portable," said Lucy; "it can easily be carried from place to place. It must be convenient to travellers. But

is it in any other way better than the barometer which hangs up in papa's room, or than that which stands upon three legs in my uncle's library?"

Harry said, that he was not sure that it was better for common use, to show the changes of the weather; "but this," said he, "is not merely a weather-glass, as barometers are sometimes called. This is intended for another purpose."

"What other purpose?" said Lucy.

"First, let me tell you why my uncle gave it to me," said Harry; "because he was pleased with my having taken pains, two years ago, to understand the barometer, and with my remembering it now. Then he bid me try to find out the particular use of this portable barometer."

"And did you, Harry?"

"Yes, but I was helped. My father, who was present, put me in the right road. I was very stupid at first. My head went quite off the wrong way, but my father was very patient, and brought it back again, and set it upon the right



road. Still I was very slow. My uncle thought I should never find it out. He said it was too difficult, and that my father had better tell me. But papa said he was almost sure that I should find it out myself. This encouraged me, and I tried and thought again, and my uncle left off walking up and down the room fretting. He was so good as to be patient too."

"That was kind of him," said Lucy; "I know it is very difficult to be patient with people, if they are slow in finding a thing out, when one knows it all the time. One longs to tell, or to push them on to it."

"Papa did not *push* me," said Harry, "that would have thrown me down; but he pulled, he helped me on gently, step by step, as he does so nicely; and he let me find it out at last quite by myself."

"Well, then, you can do the same for me, Harry."

"I will try," said Harry.

"Thank you. But first let me tell you

all that I have been saying to mamma, and all that mamma has said to me."

She repeated it all, as well as she could, ending with, "Mamma tells me that I may *go on* with you, Harry, as we used to do; and she said she thought that you would be so kind as to bring me up to you in all you have been learning."

"I will try," said Harry.

"I hope I shall not be very stupid," said Lucy.

"No, no, Lucy, I dare say you will not; do not begin by thinking you will, that is a very bad way; because then you go on, thinking you are afraid you will be stupid, instead of attending to what is asked and said to you. Now, Lucy, suppose you were at the bottom of a deep well."

"If I were at the bottom of a well, then I should find out the truth; because you know the common proverb, as Mr. Cranbourne said, that truth is at the bottom of a well."

"Nonsense," my dear Lucy, cried Harry;

"now if you go to your wit, and what Mr. Cranbourne says, I cannot attempt to talk to you about the barometer."

"Well, I will be very attentive," said Lucy. "Suppose, then, I was at the bottom of a well. But should not I be drowned?" added she, in a low voice.

"Very true, I should not have said the bottom of a well, but the bottom of a deep pit," said Harry.

"Oh, that is another affair," said Lucy, "I like that better. Now, then, I am at the bottom of a deep pit."

"Now, then, which do you think would weigh the heaviest, the air at the bottom of this pit, or the air at the top of a high house?"

"I think it would weigh heaviest at the bottom of the pit," said Lucy.

"Why?" asked Harry.

"Oh! my dear, such an easy question," said Lucy.

"Well, answer it at any rate," said Harry.

"Because, in the bottom of the pit,

the air in the pit is added to the air that is above the pit, and also you must add all the air that reaches to the top of the house."

"I believe you understand it. Suppose you took this barometer to the bottom of the pit, do you think that the mercury would rise or fall? My dear Lucy pray think before you answer."

Lucy thought, and answered: "I think it would rise at the bottom of the pit."

"Right; now if you took it to the top of a high house, would it rise or fall?"

"I think it would fall," replied Lucy.

"Why?" said Harry.

"Because then there would be less weight pressing upon the quicksilver in the cup, and therefore less quicksilver would be pressed up into the tube."

"Very well indeed, Lucy; I see you remember all papa taught us about the barometer. Now suppose the pit was sixty feet deep, and that the house was forty feet high. Forty and sixty make a hundred, you know."

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"To be sure," said Lucy. "Well?"

"Well," said Harry, "I must go slowly. Suppose that you observe exactly how much the quicksilver falls, when you take it from the bottom of the pit to the top of the house, you would have a measure by which you could judge of the whole height and depth."

"I see I should," said Lucy; "I see! I see the use of your barometer, and it is very useful."

"But you do not see all yet," said Harry. "By marking this you would not only know how much the quicksilver falls in that hundred feet; but by dividing it, and making a scale, you might know the same thing afterwards, in any number of feet, in any height to which you might take the barometer; and by this you would have an easy way of measuring the height of mountains."

"Very ingenious! very convenient!" said Lucy. "Now I understand the use of your portable barometer perfectly."

"Not perfectly," said Harry. "There

is a great deal more to be learned about heat at different heights, and rarefaction of the air. But I will not puzzle you with that, especially as I am not clear about it yet myself. But this is the general notion, which papa says is quite enough at first."

"Quite enough for me," said Lucy. "Thank you, Harry, for telling me no more."

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"I WISH! oh how I wish!" cried Harry, "that we had a mountain to measure with my portable barometer!"

"But," said Lucy, "a mountain will not come to you, for wishing for it, any more than to Mahomet."

"Mahomet!" repeated Harry. "What do you mean?"

"Do not you know, Harry, the common saying, Since the mountain will not come to Mahomet, Mahomet must go to the mountain? You were by, Harry, when I read this in our Universal

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History to mamma. Do not you remember it?"

"No, I forget it. How much better you, Lucy, remember some sorts of things than I do."

"And how much worse I understand other sorts of things than you do! therefore, as mamma says, we can help one another, and then in time we shall know twice as much between us. My dear Harry, how convenient that will be, and how happy we shall be."

"Very happy; but we cannot be always together," said Harry, "so we must learn to remember what we want for ourselves, or it will be rather inconvenient when we are separate."

"We shall not be separated for a great while," said Lucy. "Papa said yesterday to mamma, I heard him, that you are not to go to school yet."

"I am very glad of that," said Harry, "for I shall be so happy going on at home, learning from my father, and with you, Lucy! But, my dear, to go back to Ma-

homet, for I do not like to let that go, without in the least understanding what it means."

"Never mind ; only a bit of wit," said Lucy.

"But cannot you explain it to me?" said Harry.

"No, it is so easy, that if you do not see it at first, I cannot make it plainer," said Lucy.

"Do try," said Harry.

"It means only that Mahomet was foolish for commanding the mountain, in a braggadocio way, to come to him; and when all the people standing by expected, perhaps, that the mountain should obey him, and come at his bidding, and when it did not stir, he came off in a shabby way, by saying, that since the mountain did not come to him, he must go to the mountain."

"Is that all!" said Harry; "but you told me it was a common saying."

"Yes, afterwards it came to be a com-



mon saying, whenever a person proposes something, which seems fine and grand, and which they cannot really do, and when they come off with doing something common and easy, then comes the saying about Mahomet and the mountain."

"Thank you," said Harry, in a tone as if he had said, "Thank you for nothing."

"But still I do not understand how this applied to my wishing for a mountain to measure with my portable barometer."

"Oh! my dear Harry, do not be so grave about it," said Lucy.

"I only look grave, because I am trying to understand," said Harry, "how the story applied."

"I suppose it did not *apply*, as you call it," said Lucy, after considering for a few moments. "But do not let us talk any more of it."

"Only tell me how it came into your head?" said Harry.

"I cannot tell," said Lucy: "when you

said something about wishing the mountain would come to you —”

“No, no,” interrupted Harry, “that was not what I said exactly.”

“Well, never mind *exactly*, about such a thing as this, my dear Harry,” said Lucy; “I only know, that whatever it was that you said, the sound of the words about mountain, brought the mountain and Mahomet into my head.”

“The sound of the words,” said Harry; “so, after all, the words only came jingling into your head from the sound, and had nothing to do with the business; and I have been all this while trying to make sense of nonsense.”

“I told you it was nonsense at first,” said Lucy.

“You told me it was wit,” said Harry.

“Well, my dear, if one tries to explain wit, it often turns into nonsense.”

“Then what great good is there in wit?”

“If you understand it at first, it is very diverting; that is good,” said Lucy.

"But if I cannot understand it at first," said Harry.

"Why, then, I cannot help it," said Lucy.

"That is rather provoking," said Harry.

"More provoking for me," said Lucy, "this time. I have been trying and trying to explain; but in explaining, the wit is lost, the pleasure at least is all gone."

"But that was not my fault," said Harry.

"Yes, but it was, my dear, for not understanding it at first."

"That is the same thing you said before, my dear Lucy."

"Because it is the truth, my dear, and I have nothing else to say, Harry."

"And I have only to make the same answer I made before, Lucy; that if I cannot understand it I cannot."

"And I come round again to 'I cannot help it, Harry.'"

"That is arguing in a circle, as papa says," observed Harry.

"I do not know what is meant by

arguing in a circle," said Lucy; "I suppose it is something in Euclid."

"No, my dear, Euclid never argues *in* a circle, he only argues *about* a circle or circles."

"*In* and *about*," said Lucy; "Oh, let us say no more about it. I hate saying so much about one thing."

"I like to stick to one thing, till I understand it," said Harry.

"But when you can't!" said Lucy; "you really are so slow, Harry, about wit."

"Perhaps I am a little slow," said Harry; "but recollect, Lucy, that you acknowledged yourself, at last, that the story did not apply, so how could I understand it?"

"Well, I acknowledge," said Lucy; "but that excuse will do only for this once."

"I dare say I shall find another next time," said Harry. "But now look, Lucy, at those two men carrying that

long ladder across the lawn. What are they going to do with it, I want to know?"

They were going to carry it to a church in the village, the steeple of which wanted some repair; his father followed the men, and Harry asked if Lucy and he might go with him. His father gave him leave, and Harry carried his portable barometer with him, saying, that he thought he could try it at the top of the church.

In the church there were stairs which led up to the gallery, but there was no way of going up to the top of the tower, but by means of a ladder. The men fixed it steadily, and Harry's father went up. Harry wanted to follow, but his father said he must not come yet, because he had not time to think of him, till their business was finished.

"My dear Harry," said Lucy, "I think it is very dangerous; you will never be able to go to such a height. I am almost afraid to look at papa going up, it makes my head giddy."

And when his father called him, she held the flap of his coat, and said, "Indeed, Harry, you had better give it up."

"Give it up!" no, that he would not.

He began to run up the ladder with the barometer in his hand. But his father called to him and bid him "stop," and ordered him to give the barometer to one of the masons, who was behind him, whom he requested to carry it for him, and to follow him up the ladder.

"Oh! papa, I am used, you know, to mounting ladders, and I am safe without any body to take care of me."

"Do as you are desired, or you shall not come up at all," said his father.

Harry obeyed; and when he got high up on the ladder, he felt that his father was right; for though he had been used to go up ladders, he had never gone up one that was nearly so high. He felt an unusual sensation of giddiness in his head. He was glad the man was close behind him, he held fast to the sides of the ladder, stepped up very carefully, and seized

his father's hand, who was waiting for him at the top. When landed safely on the roof of the tower, he looked about him: when he looked down, his head still felt a little giddy, and it was some moments before he recovered himself sufficiently to think even of his portable barometer. Then he recollected, that, in his hurry to come up, he had forgotten to mark how high the mercury stood when he was on the ground. He did not like the thoughts of immediately going down the ladder again. It occurred to him, that it would do exactly as well, to mark the height at which the quicksilver now stood, at the top of the tower, and afterwards to see how much it would rise when he got to the bottom; but Lucy had his pencil and paper below. He wrote the figures on a bit of slate, which one of the men had in his hand. After being a little used to it, he grew quite at ease at this height, and could think as well as when on the firm ground. When he was to go down the ladder, he was a little startled by hear-

ing Lucy cry out, " Oh, Harry, take care."

His father stopped him, told Lucy she was very foolish to call out, desired her to go into the church, and wait there till they should come; which she did, and very glad she was, when she saw Harry and her father come down safely.

Upon examining the bit of slate, on which he had written his figures, and which he had put into his bosom while he came down the ladder, he found that they were so rubbed, that it was impossible to make them out.

Lucy, who was afraid of his going up again, was by turns sure, that one figure was an eight, a nine, or a nought.

This would not do for Harry, he must go up again. His father said he was right; and this time he wrote down what the barometer was before he went up, and carried paper and pencil with him. His father was so good as to accompany him. It was all done rightly, and this time Lucy did not say a word till Harry's foot was



off the last rung of the ladder, and safe on the ground.

Now they knew exactly how much the quicksilver had fallen, in going up to the top of the tower, and at what it had stood at the bottom. Harry said, that this must be compared with a table of measures, which he had at home, which would tell the height, in feet and inches.

And here be it noted, that on this, and many other occasions, Lucy's readiness in arithmetic was of use to her brother, when he came to his calculations. The habit of writing her figures exactly underneath each other, in the right rows, and of drawing straight lines and making neat little figures, all proved of advantage when she was called upon to write down totals for him in a great hurry, or to go over and copy clearly his scrawled sums in addition, multiplication, subtraction, and division.

On the present occasion difficulties occurred, and Lucy sat beside Harry for a quarter of an hour, writing down and rub-

bing out figures upon a slate, and complying by turns with contrary orders.

"Lucy, my dear, write down 452, and subtract it from 930 — have you done it?"

"Stay a bit — presently — yes."

"My dear, I meant to say *add*, did I say subtract? — no, add, add."

"Well, I have added."

"Now multiply that by — no, stay — first it must be divided — stop. — I do not understand this table: there is something about height above the level of the sea here, that I cannot make out. Then what is this *about expansion*," continued he, reading. "Oh, my dear Lucy; we are all wrong. I do not know how to allow for the thermometer; and here is a calculation about expansion and proportion, and heaven knows what. Oh! it is all wrong — I do not know what I am about."

This Lucy had suspected, but she had the good nature not to say so; and as all she had done was right, she found it easy to be patient. Harry ran to look for the article *portable barometer*; no, *ba-*

*rometer, portable*, in a Cyclopedia; but there opened to Harry's eyes such a quarto scene of tables, and fractions, and algebraic signs, as quite dismayed him, and Lucy stood in stupefied silence beside him. At length he observed,

"There is a great difference between having a general notion of any thing, and knowing it thoroughly. I thought I understood the use of this barometer perfectly, but when I come to try, I cannot make it out well."

"It is too difficult," said Lucy; "you will only puzzle yourself"—(she offered to shut the book).

"No, no, I will try and puzzle it out, and when papa comes in, he will help me, and show me my mistake."

When his father came in, he did help Harry, and with his assistance, and patience, it was all made clear.

"But after all," said Lucy, "though you have found out the height of the church, it was a difficult way of doing it, with all these calculations. Would not

it have been easier to have measured it by letting down from the top a string and a weight, a plumb line, as it is called I believe; then you could have measured the string, and you would have had no difficulty."

"Very true," said Harry, "that would have been the easiest way in this instance, because we could get to the top of the church at once, and let down a plumb line; but consider, Lucy, when we want to measure high crooked mountains, miles high, with ins and outs, and ups and downs, how difficult that would be. Besides, this puzzle with the portable barometer would not plague me again; it was only because it was my first time of trial; and I am glad that we have conquered the difficulty."

"It is very good of you to say *we*, for I did nothing but write down the figures, and do the sums," said Lucy.

"But that helped me very much, and thank you for doing it so patiently. You

did not yawn above six times. And now, my dear Lucy, if we had but a mountain to measure !”

“How happy we should be going to the top of it together, at any rate,” said Lucy.

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“LUCY, your hair is hanging into your eyes this morning,” said her mother.

“Yes, mother,” said Lucy, “because it is quite out of curl.”

“Did you curl it last night, Lucy?” said her mother.

“Yes, mamma, I did indeed ; and it curled very nicely this morning early ; but I went out in hopes of meeting my uncle, who was to have come to breakfast : and by the time that I came in again, my hair was all as you see. The breakfast bell rang, and I had not time to curl it again.”

Her mother was satisfied, since Lucy had not neglected to curl it at night,

which had sometimes been the case. Her father asked, if she knew what had uncurled her hair when she went out.

"The damp of the morning, papa," said she: "*my* hair always goes out of curl in damp weather."

"So does mine, Lucy," said her mother. "It is not peculiar to your hair, to go out of curl in damp weather."

"But, Lucy, what do you mean by your hair going out of curl?" said her father.

"Just what you see, papa; that it hangs straight."

"You told me the moisture of the morning uncurled it; do you know how or why it does so?" said her father.

"No, papa, not in the least; I wish you would tell me."

"When your hair is curled, the parts of one side of each hair are pressed close together, and the parts on the other side are stretched out. Give me that piece of packthread."

It was loosely twisted. He coiled up a bit of it, and showed her, that in the

inner circle the parts are pressed together, and in the outer they are stretched.

"Now I see," said Lucy; "and you mean, that it is just the same with my hair, when I curl it. But still I do not understand how the damp straightens it."

"That you shall see directly," said her father; and he dipped the curled packthread into a cup of water; when it was all wet, it became straight.

"Yes, it has uncurled, like my hair," said Lucy. "But how?"

"Look, and you will see, that the water has filled all the interstices, or vacancies, which you observed between the different parts of the cord. Now there are in your hair, and in all hair, pores, or small vacancies, which can be filled with moisture, like the interstices in this packthread, and which imbibe moisture from the air, as this packthread imbibed the water, and you see it filled the pores on the inside, as well as on the outside."

"Thank you, papa," said Lucy, "that is very nice. To know why my hair un-

curls is at least a comfort. Now I understand it all."

"Not all," said her father. "There is a property of hair which you do not yet know; that when it is wet, that is, when its pores are filled with moisture—"

"I see, papa; you mean it swells out, and becomes thicker, like this cord."

"Not exactly like that cord, Lucy; that cord shortens as it swells out in breadth; but hair lengthens when it is moist. All human hair is easily affected by moisture."

"Very easily, indeed," said Lucy, dividing her uncurled locks on her forehead, and trying to put them out of her way. "I was not in the damp above ten minutes, and yet you see how straight my hair has become. Indeed, papa, as you say, human hair is very easily affected by moisture."

"Yes, fortunately," said Harry.

"Fortunately!" repeated Lucy; "unfortunately you mean. Why do you say fortunately?"

"I have a reason, and a good one,"



said Harry. "It is fortunate that hair has that property. For one reason, for one purpose, useful to all men and women, but especially to men of science."

"Fortunate and useful!" said Lucy. "Brother, how can it possibly be fortunate or useful to you, or to men of science in particular, or to any body, that my hair should so easily go out of curl in damp weather?"

"Not your hair in particular, Lucy, but hair in general," said Harry.

"What use," said Lucy, "if every body's hair in the whole world was to go out of curl like this every damp day—what use could it be but to make them all look very deplorable, as mamma says I do when my hair is in this condition? What good would this do to men of science, or any men?"

"You do not understand me," said Harry, smiling. "Did you never hear of an hygrometer?"

"Hygrometer!" said Lucy, "Yes, I have often heard of an hygrometer. I

heard papa talking to you about hygrometers very lately, and reading a great deal, last Wednesday—no, last Thursday.”

“No matter,” my dear, interrupted her father, “what day you heard me reading about it: do you know or do you not know what an hygrometer is?”

Lucy confessed she did not know *exactly* what it was; but she thought it had something to do with a barometer and a thermometer, because it ends in *meter*; and she remembered long ago her father had told her, that *meter* meant *measure*, and comes from some Greek word that means to measure; therefore, she supposed an hygrometer must be a machine, or an instrument for measuring something, but what, she did not know; she guessed it was something about the air.

Her father said, that she was so far right in thinking that it is an instrument used to measure something. He told her, that it measures moisture in the air; and that the name hygrometer is composed of

two Greek words, *hugros*, *moist*, or moisture, and *metron*, *measure*.

Lucy liked this name, which contains, as she observed, the history of the thing; and now she knew this, she thought she could never forget it.

Their uncle had not yet come in to breakfast, and their father beginning to read the newspaper to their mother, Harry and Lucy went on at the farther end of the room, talking to each other.

"Now you can guess," said Harry, "why I said that it was very lucky that your hair uncurls so easily in the damp. You observed yourself, that you could always know by your hair whether it is a damp day or not, whether air is moist or not."

"So hair is an hygrometer," said Lucy, "for it measures moisture. I am sure my hair might say, if it could speak Greek, *Hygrometer*; or, in plain English, *moist—I measure*."

"Very true," said Harry; "but still you do not know the measure exactly of

HOW moist, how damp the day may be ; do you ?”

“ Yes, on very, very damp days my hair comes quite out of curl, as you see it now,” said Lucy, “ and hangs quite straight ; but it only comes a little out of curl on days that are only a little damp or damp-ish.”

“ A little damp ! ‘ Damp-ish ! ’ ” repeated Harry ; “ that is very well for common talking, but it does not describe exactly how damp. I do not know what degree of moisture you mean to express by damp-ish.”

“ Pish ! ” echoed Lucy. Harry would not smile.

“ You have not yet told me, Lucy,” said he, gravely, “ how the hygrometer is made to show the measure of moisture exactly.”

“ I do not know *exactly*, brother. But suppose, for instance, you knew how long my hair is when it is quite dry ; then in damp weather when it is moist, and hangs straight, you could measure how long it

has grown; I mean how much it has lengthened by the damp."

"I could measure," said Harry, "but how?"

"You could see whether my hair comes down as far as to my eyebrows, or only this far, or this far," said Lucy, touching different points on her forehead. "If I had a looking-glass I would measure this for myself."

"This might do," said Harry; "but at best it would do only for yourself; and but badly for yourself, because you must, to mark your points, have disagreeable spots on your forehead always."

"I should not like that," said Lucy, "nor would mamma, I am sure."

"Besides," continued Harry, "it would be rather inconvenient to me to run in search of you, with a pair of compasses and my ruler, to measure your hair and your scale on your forehead. This would be rather an inconvenient hygrometer."

"Rather, I acknowledge," said Lucy,

"you would twitch all the hair off my head too, in measuring each hair, I suppose; and I should be afraid that you would put out my eyes with the points of your compasses, when you came to measure the scale on my forehead. I should not like to be your hygrometer."

"I would much rather have one that would always stand or hang in my room," said Harry; "or one that I could carry about in my pocket, better still! Could you manage that for me? Could you find out how to do that? I found out how to do it."

"Did you indeed, brother? and do you think I can?"

"Yes, if you think well, and if you go on thinking," said Harry.

"I will, then. But tell me exactly what I am to think about, and what is to be done," said Lucy.

Harry pulled a hair out of his own head, and laid it on a piece of white paper before her. "There," said he, stretching it out, "you see its length. We

will suppose this hair is as dry as it can be. Now I will dip it into this bason of water. Now that it has been wet, it is longer than it was when it was dry."

"Yes; but we want to know how much longer," said Lucy. "Well, it is easy to lay it on this sheet of paper, and measure, as exactly as you please, how much longer it is when it is wet than it was when it was quite dry."

"Very well," said Harry, "and I can tell you, that you would find it to be one fortieth of its length longer. Then you have the utmost length between extreme moisture, and extreme dryness."

"And," continued Lucy, "I could divide this line on the paper between the two black dots, by which you marked the points to which it stretched when it was dry, and when it was damp; and, if divided exactly, it would be what you call a scale; you could measure how much, in different degrees of damp or dry, it stretches or shortens."

"Very well, indeed," said Harry; "and

the scale on paper would be better than on your forehead, you see. That's one point fixed."

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"That's one point gained," said Lucy, "now what is to be done next?"

"Next, you are to find out how, without the trouble of continually plucking hairs out of my head or yours, and wetting or drying, and measuring them, you might know every day or hour, or at any time you please, how damp the air is, or how much moisture it contains."

"If I could but make the hair measure itself," said Lucy, "and mark or show how far it shrinks or lengthens on this paper in any time."

"Aye, if you could," said Harry, "that is the question."

"Suppose I had a very, very, very little weight," said Lucy; "so little, that this hair could support it without breaking, then I could tie it to one end of the hair, and hang the hair by the other end to something, suppose a piece of wire stuck into the wall: and I would put this paper,



with our scale upon it, against the wall, just behind the weight, and when you look at it, you would see how much the hair had shrunk or lengthened, at any time, in damp or dry."

"There papa!" cried Harry; "Lucy has made out as far as I did the first time I thought of making an hygrometer!"

Lucy looked much pleased with herself, and with her brother for being pleased with her.

"And have I really invented an hygrometer, Harry?" cried she.

"Yes, but not a perfect one, my dear," said Harry; "there is a great deal more to be done."

"What more?" said Lucy.

"To come to breakfast, in the first place," said her father.

This Lucy was ready to do, for she was a little tired; but by the time she had refreshed herself by eating half her breakfast, she returned to the question—"What more is to be done, brother, about the hygrometer?"

"To make it more convenient," said Harry. "In your way, it must always be stuck up against a wall; and besides, your divisions are so very, very small, that you can hardly see how much the hair lengthens or shortens."

"You might take a magnifying glass," said Lucy.

"Well, that would help; but cannot you think of another way?"

Lucy thought for a little while, and went on eating her breakfast, and presently answered, "No, brother; I can think only of taking a larger magnifying glass, a glass that magnifies more. Will that do?"

"Still there is an easier method; put the magnifying glass out of your head."

"It must be a more difficult, instead of an easier way, for I cannot find it out," said Lucy.

"But it is easier, I assure you, when you have found it out," said Harry. "Come, I will help you a little," continued he, after she had considered for some time. "Look at the hand of that

clock," and he pointed to the dial-plate of a pendule, which was on the chimney-piece opposite to the breakfast-table. "Look, the hand now points at ten. Do you see how far it is from ten to eleven? Suppose that hand was to move from ten to eleven?"

"Well, suppose," said Lucy; "I can easily suppose this."

"Then which would have moved the farthest? which would have gone over the most space? the point of the hand, which is at the outside of the dial-plate, or that part of the hand, which is closest to the centre?"

"The point of the hand, which is at the *outermost* part of the circle, would have gone the farthest; I mean, would have moved over the most space. The part nearest to the centre would have moved so little, that I suppose I should hardly be able to see or measure by my eye how much."

"True," said Harry, "you could not; but you could see, and you could measure

the space from ten to eleven easily; could not you?"

"Certainly," said Lucy.

"You could guess the measure even by your eye, without taking compasses or magnifying glass," said Harry.

"Now I see what you are about," said Lucy; "I must have a little, *leetle* hand, and dial plate, for my bygrometer, to show and to measure the least motion of the hair in shortening or lengthening."

"Right," said Harry; "so far right."

"Do not tell me any more," said Lucy; "I can do it all for myself now, and in a minute."

"Do not be in such a hurry, my dear," said Harry, "or you will never do it."

"Hurry! I am not in the least hurry," said Lucy, "only I like to be quick. Well, I would fasten the end of the hair to the axle, so as to make every, the smallest motion of the hair, move the hand."

She paused. She was not quite clear of the manner in which this was to be done.

"I will help you," said Harry. "Suppose —"

"Suppose," said his mother, "that you were to let Lucy finish her breakfast."

"I will, and welcome," said Harry; "for now she has the principle of an hygrometer, which papa was explaining to me the other day, and of which I will show her a plate after breakfast —"

"A plate!" said Lucy; "I may as well have the plate at breakfast, may not I?"

"By a plate, I mean an engraving," said Harry; "did not you know that?"

"Oh! yes, to be sure," said Lucy; "I was only in play."

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BREAKFAST finished, Harry went to the library to look for the book, and Lucy followed, eager to see the drawing and description of what she had been trying to invent. He showed her in Rees's Cyclopaedia two engravings of different hygrometers.

"This," said he, pointing to one, was

invented by a great English engineer, of the name of Smeaton ; and this other by Monsieur de Saussure, the famous Swiss traveller. Yours, Lucy my dear, is not exactly either of these ; it is most like Smeaton's, but he uses a cord, with a weight hung to it, instead of a hair. It is said, however, that a hair is better than a cord for our purpose."

"And how does the other man, M. de Saussure, manage with the hair?" said Lucy.

Harry pointed to the engraving, and showed her, that one end of the hair is fastened, as she had proposed, to the axle of the hand, and the hair wound round the axle ; but the other end, instead of having a weight hung to it, is strained tight, and fastened to a frame of wood below. Then, when the hair shortens or lengthens, with dryness or moisture, it turns the axle of the hand a little, or much, according to the shortening of the hair.

"Turns the axle of the hand !" repeated Lucy. "I see it would turn, when the

hair shortens, because that would pull it round; but I do not see how, when the hair lengthens, that it would turn back the axle and the hand. I think that the hair would only loosen round the axle."

"True, Lucy, and accurate," cried Harry, with pleasure in his eyes; "but look again at this engraving. See here a weight hanging to this little cord, which is wound round the axle, in a contrary direction to the hair. The weight is just enough to keep the hair constantly strained, so as to prevent it from loosening, as you rightly said it would, round the axle, if there was not any thing to prevent it, when the hair lengthens from moisture. Then, as it is kept stretched, it turns the axle and hand."

"Yes; now I see no difficulty," said Lucy. "I understand it quite; and I am glad I told you the difficulty, for you have cleared it away. I hate to feel that I have only half understood, and to leave off in a puzzle. But, Harry, here are prints of a great many more hygrometers."

"Yes, made of different substances," said Harry; "many things beside hair, you know, can be used to show the changes of moisture and dryness; all things which show these easily. Some of them we have observed ourselves often."

"Oh! yes," said Lucy; "salt and sugar, for instance, and some kinds of wood, which *warp* with the changes of the weather from wet to dry. The wood of this window frame, I remember, was swelled so much during the rain last week, that we could not open the sash."

"Yes, that sash is made of deal; the wood of fir tree, you know," said Harry; "and this sort of wood shrinks and expands quickly with dryness and moisture."

"I recollect," interrupted Lucy, "I read something about a creeping wooden hygrometer, in the notes to the Botanic Garden. My dear, I remember it perfectly, because it was entertaining. There was a wooden automaton, a machine that moved of itself—"

"I know of no such machine," inter-





rupted Harry. "If it moved, it must have been moved by some cause."

"Well, the damp, I suppose, was the cause. Now let me go on, Harry. It was a wooden automaton, with a long back, and four feet, with iron-pointed shoes, which clawed on little by little, so that it walked, or crept, or clawed, quite across the floor of its master's room, in a month's time, from the changes of damp and dry. I do not know how, but it was very entertaining, and it will entertain me now much more if you can show me how it was contrived. There was, I remember, something about glueing the bits of wood that made the back, I do not rightly know how," said Lucy, "cross-ways."

"Cross-grain, I suppose you mean," said Harry. "We will look for it by and by, and I will try if I can understand and explain it to you. But now go on, and guess some other substances of which hygrometers are made."

"I do not recollect any more; help me a little," said Lucy.

Harry pointed to his mother's harp.

"I see mamma's harp," said Lucy, "but that only puts me in mind of the last tune she played."

"Do not you recollect that a string broke yesterday?"

"Yes, I do, and how troublesome it was!" said Lucy; "I remember that Mrs. ——"

"Stay, now, do not go to Mrs. Anybody, but think of the cause of that string breaking."

"Mamma said, that it was cracked by the sudden change of the weather."

"What change?"

"From dry to damp, I believe," said Lucy. "Oh, now I understand it; and I know what you mean. In damp weather the moisture from the air gets into the strings, and swells them out, and so shortens them, that if they are held tight at each end, they crack. Those strings are made of catgut. Catgut then would be a good thing for an hygrometer."

"Yes," said Harry; "but now I will

tell you another thing used for hygrometers, which I do not think you could guess — Ivory."

"Ivory! no, I never should have thought of that," said Lucy. "I never knew that ivory lengthens and shortens in damp or dry weather."

"It does though," said Harry; "there are a great many pores in ivory; we cannot see them without a magnifying glass, but the moisture gets into these pores, and swells it out. But now, Lucy, there is another common thing, which you see every day, which you might guess. When you dip it in water you may see its great pores swelling, without any magnifying glass; and then, when you squeeze the water out, and dry it, it shrinks so that you could hold in your shut hand, what, when full of water, was as large as my head."

"A sponge! a sponge!" cried Lucy. "But if a sponge is left in a room by itself, would it suck up water from the air?"

"Yes, whether it is left in a room by

itself or not," said Harry, "it will absorb (do not say *suck up*) moisture from the air; and it grows heavier when it is filling with moisture, or lighter as it dries. The sponge hygrometer is measured, or measures by weight, not by lengthening or shortening, expanding or contracting. You do not look as if you understand this, Lucy."

"I do," said Lucy; "but I am growing tired. I think I have had enough about hygrometers."

"No, no, you cannot be tired so soon; "guess once more," said Harry; "you may easily guess this, because it is a thing used in your dress."

Lucy had observed, she said, that her gloves often grew damp in wet weather. She guessed leather. It was not what Harry meant; but he said that he thought leather would do, and he did not know why it had not been used; perhaps as it takes in moisture so easily, it may not expand or contract equally."

Encouraged by Harry's approbation of

her good guess of leather, Lucy was willing to try and guess again. "But help me," said she.

Harry told her, that the thing he meant is stiff, and yet not so stiff but that it can be bent; it is springy and elastic.

She thought of several things which can be bent, but she could not guess right; and then, yawning and stretching herself, she repeated that she was tired, and that she could not guess any more; Harry must tell her.

"Then I will tell you — whalebone, my dear. Come, have done yawning," said Harry; "I will not make you guess any more; now I will show you something entertaining; I will show you a nice little hygrometer, made of an Arabian oat's beard."

"Show it me," said Lucy, stopping in the midst of a full stretch.

"Here, in this print," said Harry.

"Only a print! I thought you had the real beard," said Lucy.

"You might make an hygrometer your-

self, I dare say, of a common English oat beard," said Harry.

"Well, that I should like," said Lucy; "You were right after all, Harry, when you said it was lucky that my hair uncurled so easily. How odd it is, Harry, that I have been carrying all my life on my head, without ever thinking of it till this morning, one of the best of hygrometers! My having an hygrometer without knowing it, is like the man who talked prose all his life without knowing it."

"I do not know what man you mean," said Harry; "come now, look at it, this Arabian oat hygrometer, Lucy; it is the great Doctor Hook's."

"I do not care about the great Doctor Hook," said Lucy; "but let me tell you about the man who talked prose without knowing it. He was a man in a play, a very entertaining play papa was reading one evening when you were not listening. There was a maid-servant teaching her old master his letters, and asking him what he does when he says the letter u."

Now you shall be the old man, and I will be the maid, and I will teach you. Say u."

"Nonsense, my dear," said Harry.

"Not at all nonsense," said Lucy; "you may ask papa."

"Well, but I have not time now," said Harry.

"And the maid taught him to fence," continued Lucy; "if I had but a stick I would show you."

"Now your head is gone quite off to the play. I shall have no more good of you," said Harry, looking mournfully. "But here comes my uncle," continued he, as his uncle at this moment entered the room. "Uncle, will you look at this hygrometer for me?"

"I will, Harry, with pleasure," said his obliging uncle.

"And so will I, Harry," said Lucy, "to oblige you. My head is come back from the play now."

For about three minutes she was attentive, and she understood and admired, to

Harry's heart's content, the Arabian oat hygrometer.

"Then, now, Lucy, I will show you a much better," cried Harry; "one which is made of a kind of Indian grass, which grass is extremely sensible."

"Extremely *sensible* grass!" interrupted Lucy, laughing. "Uncle, I never heard of extremely sensible grass before! Did you?"

"I think *you* are not extremely sensible now, my little niece," said her uncle, "to begin punning, instead of minding what your brother is telling you. Surely you know that sensible means sensitive, that is, having quick, or great sensibility. You know these words are applied to plants, for you have heard of the sensitive plant."

"Oh! yes, to be sure, uncle," said Lucy; "I was only playing. I know the two meanings of the word sensible as well as any body; and I have not only heard of the sensitive plant, but seen it, at aunt Pierrepont's; and not only seen it, and its leaves closing up, and shrinking back



from my touch, but what is more, uncle, I have learned by heart Dr. Darwin's lines on the sensitive plant, the *Mimosa*."

She repeated them, and her uncle said, that they were pretty lines, and that she repeated them well.

"And would not they make a good motto for an hygrometer, uncle?" said she.

"Very good," said her uncle.

"And now," resumed Harry, "let me show you this hygrometer."

"One other motto, my dear uncle, I have thought of for the barometer," continued Lucy: without considering how much she was trying her brother's patience, she went on repeating, while she held her uncle by the flap of his coat,

"You charmed, indulgent sylphs, their learned toil,  
And crown'd with fame your Torricel and Boyle."

"*Torricel!*" cried Harry; "I suppose you mean Torricelli."

"No, it is Torricel in the lines, I assure you," said Lucy.

"It is Torricelli out of the lines, I as-

sure you," said Harry. "There never was such a man as Torricel, was there, uncle?"

Their uncle whispered to Lucy, that Harry was right.

"Well, never mind, it must be Torricel here, for the sake of the line," said Lucy, "else it would be too long. Let me go on, I will tell you what the indulgent sylphs taught these people." She went on repeating.

"Beautiful lines, Lucy," said her uncle; "but I am sure you cannot understand them, as you are not yet acquainted with the air pump."

"But Harry is," said Lucy, "and he will explain it to me; will not you, Harry?"

Harry looked very serious, sighed, and said nothing.

"Why do you sigh, Harry?"

"Because," said her uncle, "he is afraid that he shall never be able to make you understand the air pump, or any thing else, if you are not more attentive."

"Harry, I beg your pardon," said Lucy.

"But you know I was very attentive at first."

"And will be very attentive at last I hope," said her uncle. "Come, we will both be serious," added he, sitting down at the table; and drawing Lucy towards him, he seated her on half his chair, put one arm round her, and leaned his other on the table, in an attitude of attention. "Now Harry, explain your hygrometer, and spare the remains of that poor pen."

"But Lucy looks tired," said Harry. "Have you a mind to see the hygrometer, or not?"

"I have a *little* mind," said Lucy; "that is, I have a *great* mind to please you, brother, only we need not go through them all," said she, as he placed the plates before her.

"No, do not be frightened," said Harry; "I am not going to show them all to you; I am going to show you only the very best."

"Stay," said his uncle, putting his hand

over the engraving to which Harry was pointing. "Do not show her that, show her any other, she must not yet see that."

"Why not? I wonder why!" said Lucy.

"I have a reason," said her uncle.

"But never mind or think about that which I hide under my hand, my dear; attend to what your brother is going to show you."

"Which shall I show her, uncle?" said Harry; "shall I show her De Luc's ivory or whalebone hygrometer?"

"The whalebone, for that is the most simple, I think," replied his uncle.

Harry, with the article Hygrometer before him, began:—

"Look here, Lucy, do you see little *a*, and little *b*; this represents a small thin bit of whalebone, cut across the grain; you know what is meant by the *grain* of the whalebone; but do you see little *a* and little *b*?"

No; Lucy, instead of looking at little *a*, *b*, was peeping at the back of the page, and reading something about a little

man, and a little woman, and a weather glass.

"Here is something very entertaining, brother," said she, "I must read it to you.

"In the Dutch toys called weather glasses, one end of the index supports a small image of a man, and the other of a woman. The former appears, or is brought out, in bad weather ; the latter in fair weather."

"I remember," said Lucy, "that once, at our widow Green's farm, I saw a weather glass of this sort; but I was not then wise enough to know that it was called an hygrometer."

"There is no great wisdom in knowing that *name*," said her uncle.

"I wish you would show me how to make this thing, brother," said Lucy ; "that would be something indeed."

"I can," answered Harry, "and I will another day, Lucy ; but I can show you but one thing at a time. Now pray mind what you are about, because I have other things to do."

"Yes, Lucy, consider your brother's

time," said her uncle; "he wants to go to his own affairs; pray mind what you are about."

"I will, I will indeed, uncle; I will Harry," cried Lucy.

Harry began again with,

"Little *b* is a thin piece of whale-bone, cut across the grain." He was going on with his explanation, and went through *c*, *d*, and *e*, confident that Lucy was following him; but by that time he heard the sound of an ill-suppressed laugh, and, looking up, he saw Lucy with both her hands pressed against her mouth, to prevent her laughter from bursting forth.

"What can you be laughing at, Lucy?" said he.

"Only at the odd figures of the little old man and woman, in the weather glass, which I never can think of without laughing: the woman with her cap and red ribbons all awry, and her eyes crooked too, and her arm a-kimbo, and her pipe in her mouth, doubled back against her snub

nose, flattening it this way. Look Harry, look uncle !”

Her uncle, instead of joining in Lucy's merriment, said gravely, that she was wrong to waste her brother's time, and that he was afraid she would never learn any thing of science, if she were not more attentive.

Her mother came into the room while her uncle was speaking, and Lucy looked ashamed and mortified : writhing as if with bodily pain, she said, “I did attend as long as ever I could, but I could not any longer, I was so shockingly tired.”

“It was my fault,” said Harry ; “I kept you too long, and told you too much at a time ; but I did that, because you told me you wanted to get on, and to learn all I had learned as quickly as possible.”

“That is true,” said Lucy ; “I was wrong there, I confess.”

“And since we are all confessing,” said her uncle, “I suppose I should confess I was wrong in praising you, Lucy, for repeating those lines.”

"Yes, indeed, my dear uncle, I think you were," said Lucy; "for that encouraged me to repeat more, though I knew my brother did not like that I should."

"I was wrong, I suppose, not to like it," said Harry; "but I will try to like poetry better."

"And I will not repeat it at the wrong time," said Lucy. "But Harry, another day, you must not tell me such a quantity, and keep me so long *at it*."

"I will not," said Harry; "I know it was wrong; but I was so eager and happy myself. And besides, you said you wanted to get on fast."

"Well, but I will be content to go a little slower, and not to do so much at once."

"Right, my dear Lucy," said her uncle; "the only way to be quick at last, in science at least, is to be content to go slowly at first."

"You may remember, Lucy," said her mother, "that was the way you began in arithmetic; you used to tell me every day,



‘mamma, this is very slow work;’ but now you can go on with it quickly.”

“A great deal more quickly than I can, I am sure,” said Harry. •

“Well Harry, I will be as slow as you please in scientific things,” said Lucy.

“And I will never tire you again so sadly,” said Harry, “if I can help it.”

“I will never be tired again,” said Lucy, “if I can help it.”

“If I can help it,” repeated their mother, “is a wise and safe addition.”

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THE next day, Harry and Lucy, having finished their morning’s business, were anxious to return to the hygrometer, and to try their resolution of mutual forbearance. But they had taken no exercise this day. Their uncle advised them to run out to their gardens, and divert themselves for an hour or two.

“Remember,” said he, “Æsop’s good old fable, and excellent principle of unbending the bow.”

"Yes," said Lucy, "the strings of mamma's harp never crack when she remembers to *let them down*, to loosen them in time."

After having refreshed themselves by an hour of that voluntary hard bodily work, which children of all ages agree to call play, and after they had rested and cooled themselves, while they gathered a basket full of their own strawberries, of which of course they ate a proper proportion to determine whether they were or were not ripe, they returned to the house, intending to offer these their first strawberries to their uncle. But not in the library, nor in the breakfast room, "nor up the lawn, nor at the wood was he;" and it was concluded, that he was gone home to his own house, which was about a quarter of a mile's walk from theirs.

"We had better run after him with our basket," said Lucy.

"No, he will come back before dinner, I am sure," said Harry; "for mamma said he was to dine here, and there is his great

coat still in the hall. Now let us go to the hygrometer."

Lucy set down her basket of strawberries at the farthest end of the room, lest the smell should disturb her, and Harry took down and opened his large volume. But their hands were in no condition to touch delicate engravings: his were brown with garden mould, and hers pink with the juice of strawberries. The dressing bell had rung, and their mother strongly advised their dressing before they began to read.

This advice, *to dress first, and then you are ready to do whatever you please afterwards*, so often given by age-to youth, and so seldom taken, or well taken, was in this instance acted upon instantly, without one murmur of the tongue, or one writhing of the body.

In all the self-complacency and safety of being ready half an hour before dinner time, they met again in the library, where they found their uncle.

"Oh! uncle, I am glad you are here,"

cried Lucy: and after presenting to him their strawberries, they went to their book.

Harry asked whether he should go on with *old whalebone* or not?

"Go on with old whalebone," said his uncle. "Lucy should not leave that without understanding it: not that it signifies whether she understands that particular thing or not, but this will be a trial of her attention."

"I will be very attentive," said Lucy. But observing that her uncle placed his arm as before, so as to cover one of the hygrometers in the engraving, her curiosity a little disturbed her. Her uncle remarking the turn of her eye, said,

"I advise you, Lucy, to repress your curiosity. Do not think of what is under my elbow, but of what your brother is showing you."

Lucy repressed her curiosity, and commanded her attention. Harry explained slowly, and she followed step by step patiently, undisturbed by the fear of being too slow, or the hope of showing that she

was very quick ; and without one glance at her uncle's arm, or one thought of what might be his reason for keeping it in that position, she went regularly through the *a, b, c, d*, of De Luc's whalebone hygrometer, and understood it to her own, and to her brother's complete satisfaction. Her uncle was, as he said, glad to perceive that Lucy had so far kept her resolution ; and he told her, that if she steadily went on in the same manner, she would find it in time easy to do what she now felt so difficult, to fix her attention.

"And now," said he, removing his arm from the print ; "you shall know my reason for covering this, and I will show you what I went home for."

He took from his pocket, and placed between Harry and Lucy, a small cylindrical case, of about three inches high, covered with morocco leather.

"It is like the case of mamma's opera glass," cried Lucy. "Is there an opera glass in it?"

"No ;" Harry smiled, for he knew what

was in it immediately: he knew that it was his favourite hygrometer. His uncle took it out of the case, and placed it beside the engraving which he had covered with his arm, telling Lucy, that he had wished only to delay showing her the engraving, till she could compare it with the original, which he had walked home to bring for them. It was so simple, that upon looking at it, and examining the plate, Lucy understood it directly. It is composed of a kind of Indian grass, which, like the beard of the Arabian and of the English oat, twists and untwists with dryness or moisture, but in a much greater degree, making, it is said, from ten to sixteen revolutions, from the extreme of moisture to the extreme of dryness. Harry told Lucy, that in the description which he had read of this hygrometer, it is said, that it shows, more easily and quickly than any other, the changes of moisture in the atmosphere.

“It is so sensible,” continued Harry, “as to be affected by the shutting and

opening of a door or window, and is sure to feel the approach of any person, and to indicate it by the motion of its hands."

"Let us try now, if it will indicate my approach," said Lucy.

As she approached, the hands began to move; and when, as her brother bid her, she took it up and held it nearer to her, the motion increased; and when, as he desired, she breathed through the holes in the sides, one hand, affected by her breath, seemed to fly round the circle, while the other numbered the revolutions. Lucy was pleased full as much even as her brother could expect. She stood watching its quick variations as she breathed upon it, or withdrew her breath.

"But, brother," said she, "did not you tell me that this has been but lately invented. How comes that? Why did not people think of it before? Was not the grass always there, wherever this was found — in India?"

"I suppose it was," said Harry; "but

nobody had observed it. All I know about it is, that in Rees's Cyclopedia, it says, that this kind of grass was discovered in India about the year 1800, I think, was not it uncle? by Captain Kater, who was employed in making some survey, or some observations, and who wanted a very accurate hygrometer to measure the smallest quantities of moisture; and he tried this grass, and found it succeed, and found that it lasts better and is more sensible than the English oat."

"Accurately remembered, Harry," said his uncle; "but pray does the Cyclopedia tell you how it happened that Captain Kater took notice of this grass?"

"No, uncle," said Harry; "how was it?"

"He told a friend of mine, that one evening, as he was walking without boots in that grass, he was annoyed by its frequent catching in his stockings; and when he took them off at night, he found them full of this grass, which had twisted itself



into them. When he pulled it out, he observed it particularly. Then his attention being fixed, he remarked the sensibility of this grass to moisture, and he thought of using it for his scientific purposes, as an hygrometer."

"How very lucky, that it plagued him that day," said Lucy, "by sticking in his stockings."

"How well it was, that he observed its properties, when he took it out," said Harry, "and that he thought of applying it to some good use. I am afraid I should have thrown it away without observing it: at night, particularly, I might have been sleepy and tired; and then, uncle, the world would never have had this nice little convenient instrument."

"Would you, Harry, and would you, Lucy," said their uncle, "like to have this nice little convenient instrument for your own?"

Their eyes brightening with pleasure, they answered that they should like it very much.

"Then it is yours, my dears," said their uncle. "I give it you in the hope that it will teach you accuracy and patience."

They said that they would try to keep a register of it regularly, but Lucy added, that if it was only to teach her patience, she should not like it so well as if she thought it would be also of some use to her uncle, or for some other purpose.

Her uncle assured her, that it would be useful to him; he said, that he had two friends, one living in Ireland, the other in America; they wished to keep a register of the damp or dryness of the atmosphere in those countries, to be compared with England.

"Then," cried Lucy, "we will keep the register for England with pleasure: that will be something grand, and worth while."

"But," said her uncle, "if you attempt this, it must be done with accuracy, or it will be of no use. Remember, I tell you, it will be a trial of

your patience. Do not begin it unless you think you can keep it regularly for six months."

"Half a year!" said Lucy, "that is a very long time." Harry, however, was not afraid to undertake it; because he had tried, and had kept a register of a barometer for a whole year. He said his register was not neat, though it was accurate; his figures were too large, and straggling often out of their proper columns; but now he could use Lucy as his secretary, and she could make nice even figures.

Their uncle wrote for them some necessary directions. He said, that it would be requisite to do, every time they registered their hygrometer, a sum in division of a certain large number of figures. This did not alarm Lucy, for she was expert in division, and she rejoiced that she should be able to do this sum readily for her brother; and that she should be wanted and useful every day, or may be

twice a day. They were eager to show their hygrometer to their father; but he had gone from home for a few days.

It was settled, that the first thing they should do every morning of their lives must be, to examine and write down their hygrometer registry. Harry was always to *read off*, and Lucy to write down.

Whoever has tried to keep a daily register, or to do any thing regularly every day, and at a certain hour, must know, that it is not a very easy task; and where two persons are concerned, the difficulty is more than doubled, with the chances of one or the other failing in punctuality, and quarrelling about whose fault it might be. Harry and Lucy, therefore, by the experienced and the candid, will be allowed some credit for keeping their register accurately every day for a month, without having complained of each other. Lucy repeated, that she was very glad it was to be of some great use to her uncle, at the end of the time; for that, without this motive, and the pleasure of helping

her brother, and of making nice figures for him, she confessed, that she should not have patience to go on with it.

“Thank you again and again, mamma, for allowing me to learn with Harry as I used to do. I am much happier already. But, mamma, if I knew ever so much, if Harry was not fond of me, and I of him, we could not be really happy. Could we, do you think, mamma?”

“In truth, my dear child, I do not think you could,” said her mother.

“I am sure, quite sure, we could not,” continued Lucy. “Suppose I knew all the histories, and all the poems, and all the stories in the whole world, and that I could draw, and play on the piano-forte, and dance better than any body in the universe, I am sure, mother, I could never be happy unless I loved my brother, and he loved me. Nor could he be happy, even if he knew all the “Scientific Dialogues,” and all the mechanics, and hydrostatics, and optics—

“But, oh!” cried Lucy, interrupting

herself in this enumeration of the *ics*,  
“there is papa come home! I could not think, mamma, what made you start up so quickly in the middle of my *optics*.”

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LUCY had too much discretion to produce their hygrometer the very moment her father came home; she waited till he had finished what he was saying to her mother; comprehending that this might be of more consequence to him, and more interesting, than even their new possession, and their new arrangements. As soon, however, as he had leisure to attend to her, when he turned to Lucy, and holding out his hand to her said, “Have you any thing new to tell me, my little girl?” she answered eagerly, “Yes, papa, a great deal!” He made room for her on one side of him, and for Harry on the other, and then they showed him their hygrometer; and Lucy told him how much she wished to understand what her brother had been learning the preceding years; and she told

him of Harry's intention to bring her up to him in science. She promising to go as slowly, and he as fast as he could, and to tire her as little as possible. Her father was glad that Harry had learned by his first attempt, that he should not, on any subject, tell all he knew to his sister at once, nor expect that she could at once take as great an interest as he did, on subjects of which she was ignorant; particularly when she had to endure all the labour and mortification, which a beginner must go through, before learning any new science can be easy or entertaining. His father advised Harry not to attempt to describe all the small parts and detail of machines, not to go over all the *a b c's* of descriptions in engravings, which, however requisite for those who are to make them, would be unnecessary to Lucy. He advised Harry to try to give his sister a clear knowledge of the principles of some of the most useful inventions and discoveries. He promised to assist whenever he came to any difficulty, but he de-

sired him to try first how he could go on by himself, in explaining to his sister. And he repeated to Lucy what her mother and uncle had said to her about attention. He told her, that whenever he had attempted lately to teach her, he had observed that she did not attend as well as formerly.

“ I know it, papa ; I try all I can, but I cannot. I do not know how it is, I cannot,” said Lucy ; “ every word that is said seems, as it were, to awaken some other words ; and every thing I see and hear makes me recollect something else, and my thoughts are flying off backwards and forwards, and sideways and every way, while Harry’s can go on straight forward, always thinking of what he is about, or of the very thing that is said to him. I used to be able to do the same,” said Lucy, sighing.

“ Sigh no more, Lucy,” said her father, smiling. “ No great harm is done. Your habits of attention have been spoiled, and your power of attending is consequently



diminished ; but with your own good will and good sense we shall soon set all this to rights again. Your perceiving and reflecting upon what passes in your own mind, will assist you very much."

" Papa," said Lucy, " I know how it all happened. Aunt Pierrepont did not think it signified much whether I attended strictly, as my uncle says, or not. She said I was quick enough. And I will tell you, papa, what made a great impression upon me. Once I heard a gentleman talking about genius ; and he said of me, that he wondered how I learned every thing with so little attention ; that I was always looking about and listening to all that people said, and yet that I was so quick. I am ashamed, papa, to tell you any more," said Lucy, stopping.

" You have said quite enough, my dear little girl, to prove to me that you are not quite a goose. As long as any person is ashamed of being flattered, there is hope that they will learn to despise and dislike flattery. I give up only those who get

over the pain of the shame, and who then like it shamelessly, and swallow down more and more of it, till at last they end by being fools to flattery, without knowing their wretched state."

"I hope I shall never be in that wretched state, mamma," said Lucy, with a look of much apprehension; "Harry, will you take care of me?"

"And of myself," said Harry.

"Well, now to business," said their father. "What do you wish to learn first, Lucy?"

She said that she wished to be made perfectly acquainted with the air pump, because Harry had reproached her with not having understood that fine poetic description of it, which she had learned by heart, and repeated. He said, that to be sure he could easily make her understand his uncle's air pump, because she already knew the principle of a common water pump.

"Do I?" said Lucy, smiling; "I did not know that I knew it;" and here she



again thought of the man who had talked prose all his life, without knowing it; but she refrained from making an allusion to him, though it was ready on her lips. Harry recalled to her mind the experiments which their father had shown them two years ago.

“Do not you remember,” said he, “the experiment he showed us, with a roll of tape that was put under a wine glass, which was turned down, and plunged into a bason of water; and then the tape was pulled out, and unrolled by degrees?”

Lucy remembered all this.

“And what happened,” said Harry, “when the tape was pulled from under the glass?”

Lucy answered, “That the water rose in the glass.”

“And why?” said Harry.

“Because, when the tape was taken out, there was left in its place a vacancy, a vacuum you call it; then the water which was in the bason rose into that vacant place.”

“And why did it rise?” pursued Harry.

“Because it was pressed by the weight of the air, pressing on all the water in the basin, and it was forced up into the glass where there was no air, nothing to prevent or resist it.”

“Very well; now I am satisfied,” said Harry. “You remember it clearly.”

“Because I understood it clearly at the time it was first shown to me,” said Lucy; “my father was so patient, and explained it to me so slowly and clearly.”

“Well,” said Harry, “you have proved to me that you understand the first principle on which pumps are made, for all depends on making a vacuum, into which the water rises, or is raised. The first thing to be done is to make a vacuum. Now, Lucy, in a common pump, such as there is in the yard for pumping up water, *where* do you think the vacuum must be before the water can rise?”

Lucy said, she supposed that it must be in the inside of the body or *tube* of the pump.

"Yes, we call it the *bore*," said Harry. "Now tell me how you would make a vacuum within it."

"Oh! my dear Harry, that is too difficult a question for me," said Lucy. "How can I tell how to make a vacuum in the *bore*, as you call it, of a great pump?"

"Where is the difficulty?" said Harry. "Do not be frightened by the word *bore*; or, if you are alarmed by the idea of a great pump, suppose a little one, as small as you please; as small, suppose, as the glass tube of the barometer."

"That would be easy to suppose; but could there be so small a pump?" said Lucy.

"To be sure, as well as of the largest size, only it would raise less water. But now go on straight forward, Lucy my dear; do not ask me any of your starting off questions. You must let me ask you questions, and you are to answer?"

"If I can," said Lucy.

"You can, I assure you, my dear," said Harry, in his most persuasive tone, "if you

will only believe that you can, and keep steady. I ask you how you would make a vacuum in this tube?"

"Let me consider—let me recollect. What did my father do when he made a vacuum in the wine glass?" said Lucy to herself. "He put in a roll of tape, which filled up the whole glass, and then drew it out, little by little, so as not to let any air into the glass, while he was pulling it out again. But I cannot get a roll of tape into the small tube," said Lucy.

"No, not a roll of tape," said Harry; "but if you consider what was the purpose or use of putting the roll of tape into the glass, and drawing it out again, you will perceive, that putting in and drawing out any thing else in the same manner would do as well."

"The purpose was, first to force the air that was in the glass out of it," said Lucy, "and to prevent any more afterwards from getting into the place which the tape took up, and which remained va-

cant as it was drawn out, leaving a vacuum at last."

"Now you are coming on very well, Lucy," said Harry.

"If I can put in any thing of any sort into the little tube, which forces the air out, and then if I could keep the air out, there would be a vacuum for you, Harry."

"Very well, you will now quite understand a pump, and you will soon know how to use it, Lucy."

"As to that," said Lucy, "I know how to pump already, only I am not strong enough."

"Stay! stay! Lucy; knowing how to pull a handle up and down, which I suppose is all you mean, is not understanding what I mean by knowing what pumping is, or how it is done."

"I have seen men and maids often pumping at the pump in the yard," said Lucy.

"What happens when they pump?" said Harry.

"The water comes out of the spout, after they have pumped a little while," said Lucy.

"What do you mean by pumping?" persisted Harry.

"I cannot tell you exactly, Harry, because I never saw the inside of the pump. I only know that they move the handle up and down; and I believe there is something fastened to it, which I suppose brings up the water; but I do not know how exactly."

"I believe not indeed," said Harry; "then you see, Mrs. Quick-Quick, you did not understand what I meant by pumping. Now come with me, and I will show you in my room the nice glass pump which my father made for me. You cannot see into the inside of the pump in the yard, but when once you have seen my glass pump you will understand the inside of all others."

He showed her in the first place a glass tube, in which there was a spout near the top. The tube was open at the top, and at the bottom there was a little door or



valve, which opened upwards only: he poured water into this tube, to show her, that the water would rest upon this valve, without its letting any of it through: he then emptied out the water. "Now," said he, "you know there is nothing but air in this tube. Look at this, which is called the piston of a pump." The piston was a cylinder, which fitted tight into the tube; at the top of it there was a valve like that at the bottom of the tube, which also opened one way, and that was upwards. Harry pushed it up several times with his finger, to show Lucy that it opened easily, and he made her feel that it did so. He then put the tube into a tub of water, the tube resting on two blocks of wood, which raised it from the bottom of the tub, so that there was room for the water to flow in through the lowest valve. Lucy, as he desired, held the glass tube upright, while he pushed down the piston, to which there was a long handle.

"Now, Lucy, what happens within-side of the tube?" said Harry.

"Nothing that I know of," said she, "but that you have pressed the air in the tube closer together."

"Very true; do you see the valve at the bottom? Is it shut or open?"

Lucy said it was shut.

"And what keeps it shut?"

"The air that you are pressing down upon it," said Lucy.

He pressed the piston down farther.

"Now look again," said he, "and tell me what happens?"

"I see the little door at the top of the piston open," said she.

Harry asked her what she thought had opened it.

"The air," said she, "underneath it, which I suppose you could not compress any more, and which has forced its way up."

He now drew up the piston, and again asked what happened. Lucy saw the valve at the top of the piston shut, and she saw the water rush through the valve at the bottom of the glass pump, and rise in

its tube. And when Harry again plunged down the piston, the water came through the valve in the piston, and when he drew it up again it carried up all the water to the top of the tube, where it flowed out of the spout.

"Just as it does in the great real pump," said Lucy.

"And now you do know what I mean by pumping," said Harry.

He pumped on for some time, and then let her take the handle, and work for herself. He questioned her, and made her repeat her explanation, till he was satisfied, and she was satisfied, that she clearly understood, that the thing to be done in pumping, and by pumping, is to force the air out of a certain space, to produce a vacancy or vacuum, into which the water rushes and rises; "Or rather," said Harry, "to speak more accurately, is pressed and supported by the surrounding air and water. Perhaps I ought to tell you, that there is no *perfect* vacuum. But I will not be too exact with you at first, lest I should

tire you. Therefore I will not tell you all the differences between a lifting pump, and a sucking pump, and a forcing pump; besides, I am not sure that I know them all myself. I will not tell you even about water always finding its own level."

"I am very much obliged to you," said Lucy.

"Nor will I tell you," continued Harry, "about the weight of the column of water, which a certain quantity of air can sustain."

"I think I do know something about that," said Lucy; "or I did know it once. However, thank you for not telling me too much at a time, especially about all the different pumps you talked of. Leave my head quite clear with the vacuum. That I understand now, and the use which is made of it; and I understand all that happens when the piston of the pump is pulled up and pushed down."

"And now that you know," said Harry, "what pumping is, I will ask mamma to let us go to the great pump in the yard,

that you may see, Lucy, the same sort of thing in large, that you have seen in small."

Their mother went with them to look at the pump in the yard. The handle was so high, that Harry could not well manage to use it; but his mother called for one of the servants, who pumped for them.

The servant filled a tub with the water, which he had pumped up; and, as he lifted it to carry it away, he said, that he and all the servants in the house were very glad, that the pump, which had been out of order, was now well repaired, because it had been great labour to them to go to the windlass-well in the garden for water, whenever it was wanted, and to bring heavy tubs of it many times a-day. This observation made Lucy the more sensible, as she said, of the great convenience of a pump.

"This is a really and truly useful machine," continued she; "useful to great, great numbers of people, for the commonest business, that must be done every

day, and almost every hour; and it is as easy for ignorant people to use, as for the most learned — what an excellent contrivance! How happy the man must have been who made the first pump, when he found it would do, and felt the water coming, and saw it pouring out at the spout!"

"Delightful!" said Harry.

"Now, Harry, my dear, tell me something about the air pump."

"No, no, my dear, that would be too much," said Harry, looking very prudent. "One pump a-day is enough for *you*. I will keep the air pump till to-morrow."

After all this wisdom, what did they do next? How did Harry and Lucy spend the remainder of this morning, two whole hours?

If we tell, we shall not be believed, except by those who are themselves children, or by those who know children right well, and their sudden falls from the heights of wisdom to the depths of folly.

Harry and Lucy spent all that remained of this morning in pumping up, through

the little glass pump, the water of a puddle in Harry's garden. They could have ladled it all out in three minutes, and two moderate sized tubs would have held it, and have carried it all away. But this would have been too obvious, too easy a way of going to work. It must all pass through the glass pump: and so they worked on till their backs ached, and till the dirty puddle water had so soaked into the leather of the piston, and so clogged the valve with mud, that it would move no more.

During this pumping and draining of the puddle, many misadventures befel Harry's trowsers and Lucy's clean frock — clean no more! It may be recorded for the advantage of little washerwomen, who, with hands unskilled, may unadvisedly attempt to wash out fresh spots, that the more Lucy tried to get rid of hers, the more they appeared. What seemed quite out while it was wet, came in again as soon as it dried. And the spots spread into blotches, with obstinate edges of yellow; so that altogether the frock, instead

of looking better for these operations, was worse than ever!

Before it was half dry — oh, how unlucky! — before it had half dried, after dip and scrub the fifth, the sound of carriage-wheels was heard — morning visitors! Their garden was full in sight of the house. Up jumped Harry, upon what he called his throne, a heap of stones, from whence he had a full view of the carriage. It was one he had never seen before. Lucy clambered after him, to share the exalted view from his throne, and to assist his judgment with her eyes and her imagination. A lady was getting out of the carriage. Lucy did not know who it was, she confessed, but she imagined that it must be a certain Mrs. Hanbury, who owed her mother a visit.

“ I am sure it is Mrs. Hanbury, and I dare say that her daughter is with her; therefore I will not go in, for Miss Hanbury is always very fine, and I should not like that she should see me in this frock in this sad condition. And oh! Harry,



they must not see you in those trowsers. I will show you how Mrs. Hanbury and Miss Hanbury would look at us. We will not go in."

"Go in! upon no account," said Harry. "As to my trowsers, I do not care what your fine Miss Hanbury or Mrs. Hanbury think, or how they look at them, or at me; but I hate going into a room where there are strangers."

Harry observed, however, that notwithstanding Lucy's certainty, that the visitors were Mrs. and Miss Hanbury, no girl got out of the carriage, and there was a gentleman.

"How can that be?" said Lucy, "for there is no Mr. Hanbury. Let them be who they may, we will not go in," repeated she.

To this Harry heartily assented. He disliked *morning* visitors particularly.

"So do I; so does every body," said Lucy. "I hope they will not see us from the house. I hope mamma will not send for us. Harry, we had better sit up

in your observatory, in the great sycamore tree."

"Come up then this instant," cried Harry. "Give me your hand, and I will pull you up."

In Harry's observatory, in the great sycamore tree, they both sat snugly for some time, till he saw through the branches some people standing at the drawing-room window. That they might not be seen by these people, Harry advised leaving the observatory, and removing a step higher, into what he called his dark attics, where the branches were so thick, that he was sure no morning visitors could see them, or think of looking for them; he had sat there many a time, he said, while ladies had passed under the tree chattering, without ever spying him. Scarcely, however, had they mounted, and safely lodged themselves in the attics, which, to say the truth, were ill able to hold two lodgers at a time, when Harry exclaimed,

"It is all over with us! there is mamma herself at the window, beckoning to us."

"But she cannot see us," said Lucy.

"Certainly not," said Harry, "unless she saw my white trowsers, when I was clambering up here into the attics."

"White trowsers! Oh no, I am sure she did not," said Lucy.

"But there she is," said Harry, "waving her handkerchief, Lucy."

"Do not go, do not go in; for now I have a green streak worse than all the rest," said Lucy; "I am sure mamma does not see us, and I dare say she does not want us really herself, but perhaps Mrs. Hanbury asked for me, and mamma just beckoned."

The signal was repeated at intervals, two or three times. Lucy had some doubts, but the fear of Mrs. Hanbury's seeing her dirty gown prevailed. The handkerchief ceased to wave, and they remained in their tree nearly an hour, a much longer time than they had expected. Harry had been resolute from the first, and had no waverings during this hour. As he sat quite at ease in his tree, he said, "Now

is a good time to think of the puzzle my uncle gave me, about a three gallon, a five gallon, and an eight gallon vessel." Lucy interrupted him several times, by scrambling up and down to see if the carriage was gone, or whether mamma waved her handkerchief again. At length, having succeeded in solving his problem, he held her fast by the gown, insisting upon her sitting still and thinking of it, which, as he assured her, would make the time appear to go much faster. "There was a gentleman who had two haymakers. One hot day they worked very hard making hay, and when they had finished the hay rick, late in the evening, the gentleman called them to his hall door, and said, 'My good men, you must be very thirsty, I will give you some beer to drink. Here are eight gallons for you; but you must divide this beer so that each of you may have exactly half, and this you must do before you drink a drop of it.'"

"That was very easily done," said

Lucy; "each was to have four. What puzzle is there in this?"

"Stay, stay, Mrs. Quick-Quick, you will be puzzled yet before you have done. The gentleman had only three vessels in his house, it is said; the first held eight gallons—the beer was in this; the second held five gallons, and the third three gallons, and these two were empty. Now manage it as you will, Lucy; and with these vessels divide the beer so that you can prove to me, that each man has four gallons exactly. You may pour the beer backwards and forwards as often as you please, from one of these vessels to another."

Lucy began, and poured from one to another in imagination for some time, without success; pour how she would, there was at the end of her measures always five gallons in the eight gallon vessel, and three in the five. At last she perceived how it could be done, and showed how she could prove to Harry

that she had divided it equally; "four gallons, Harry, in the eight gallon vessel, and four gallons in the five gallon vessel."

So completely had her attention been absorbed by this puzzle, that she had not heard the sound of the departing wheels of the visitors' carriage; and when she again peeped out of their hiding place, they were surprised to see that the carriage was gone.

When they went in their mother told them, that she was sorry they had not sooner made their appearance, because the lady and gentleman who had been with her were remarkably agreeable people, and had told many things that were entertaining and interesting.

"Then, mamma, it was not Mrs. and Miss Hanbury?" said Lucy; "how very provoking. I am sorry, mamma, we have missed hearing entertaining things. Who were the people?"

"Sir Rupert and Lady Digby, friends of your father's."

"I never heard of them before," said Lucy.

"Very likely, my dear."

"Mamma, what sort of entertaining things did they tell?" said Lucy.

"They gave us an account of a shipwreck, which happened lately on part of the sea shore, near the place where they live."

"Oh, mamma! tell it me," cried Harry.

"Yes, pray, mamma," said Lucy.

"First tell me, did not you see me beckoning and making signals to you to come in, my dears?" said their mother.

"Yes, mamma, we saw you," said Harry; "but we thought that it would be tiresome, and we did not like to go in; I liked better to go on with what I was about."

His mother told Harry, that she would not have beckoned to him unless she had thought it was worth his while to come in; "And," added she, smiling, "you must now abide by your own choice,

for I will never tell you of the ship wreck."

"Pray, at least, mamma, tell it to Harry," said Lucy; "because it was all my fault that we did not come in. I did not like to come, because—look at my frock, mamma."

"It is very much soiled, indeed," said her mother.

"With the water from my puddle and my glass pump, mamma," said Harry; "that was my fault."

Her mother asked Lucy why she could not put on another frock. "Have not you any other, Lucy?"

"Yes, mamma," said Lucy, colouring, "I have; but I could not put on any of them, because one is so short, it comes up to here; and I forgot to let down the tucks. And another has a great tear in it; I intended to have given it to be mended this morning; and one sleeve is half out of the third, mamma. I tore it last night, as I was reaching down a book from the uppermost shelf."



Her mother said, that there must be no more experiments of any kind, till Lucy should have these things mended.

"I know that is quite right, mamma," said Lucy. "I expected you would say so. I will go up to my room directly, and let down the tucks. But, mamma, while I am away, *could* you be so kind as to tell Harry the story of the shipwreck?"

"I *could*," said her mother, smiling, "but I will not. In the first place, I should be sorry to tell it when you were not present; but I do not intend to tell it to him at all; for if I were to repeat to him every thing entertaining which I heard this morning, he would depend upon my doing the same another time, and he would not exert himself to conquer that feeling of bashfulness, which prevents his coming into a room where there are strangers, and which makes him always say, 'I would rather stay out of the room, and go on with my own affairs.'"

"Now, brother, for the air pump," cried Lucy, "as you used to say, 'Now, papa, for the barometer.'"

"My uncle," said Harry, "has been so good as to lend me his portable air pump to show you. Was not it good of him to lend it?"

"Very good indeed," said Lucy; "and how convenient to have so many things portable! *Portable* barometer, *portable* hygrometer, *portable* air pump."

"Now, Lucy, recollect what was the great thing to be done in pumping," said Harry.

"Was not it to make a vacuum?" said Lucy, hesitating, as if she was afraid of making a mistake.

"Yes, to be sure, my dear," said Harry. "Be quite certain about that."

"I am quite certain," said she; "I was only afraid to say it at first, lest I should not be right."

"But do not be afraid. When you know a thing, know it very firmly. The

truth cannot alter between yesterday and to day ; nor can the truth ever alter, you know."

"That is a great comfort," said Lucy. "Was not it Boyle who invented the air pump, or was it Torricelli?"

"Neither," said Harry; "it was that poetry you repeated, which put that mistake into your head. And, when once one has got any thing wrong into one's head there is no getting it out again. But you are partly right. Boyle improved the air-pump very much, and it is sometimes called the Boylean vacuum, that is, Boyle's vacuum. But Boyle was too honest a man to claim for his own the first vacuum. I mean the first making use of it for the air pump. He knew, and always said, it was Otto Guerick's invention."

"Well, I dare say it was," said Lucy; "you need not say any more about it. I do not care much who made the first vacuum, nor who first made use of it for the air pump."

"You do not! Lucy, my dear, consider what you say. Suppose I had invented the air pump, or something as great, would you, my sister, like that somebody else should take from me the honour and glory of the invention?"

"No, I should not," said Lucy; "but you are my brother, and alive; and to be sure I should be anxious that you were not robbed of the glory. But those other people, Mr. Otto Guerick and Mr. Boyle, are nothing to me; besides, they have been dead and buried long ago, and what signifies it now to any body?"

"It signifies a great deal," said Harry. "Suppose it was my father, or my grandfather, or my great grandfather, should not I care? would not you? Then so would Otto Guerick's, or Boyle's children, or grandchildren, or great grandchildren, if there are any living. And there is a great family of Boyles, I know; and do you think that for the world they would give up the Boylean *vacuum*?"

"I suppose not," said Lucy. "But now let us go on to the air pump itself, and the vacuum, let it be whose it will."

"So we will," said Harry; "but before I show it to you, remember, that what you are going to see is a pump for pumping out air, not for pumping up water. So put water quite out of your head."

"I have put water quite out of my head. I understand that the air pump is to pump out air. But, brother, before you begin, let me say one thing."

"Say it then, if it is not poetry."

"No, it is only that I think a pair of bellows is a sort of air pump. Hey, Harry?"

"Well, that is not foolish, Lucy. You may call a pair of bellows a sort of air pump; only that bellows never could be a right air pump without two valves. But do not go on thinking of them all the time I am explaining to you. Now look at my uncle's air pump. You see this glass," continued Harry, and he pointed to a

large glass bell, which stood over a sort of frame or stand. "Lucy, what do you think is in this glass?"

"Air, I suppose," said Lucy.

"It is full of air, and of nothing else," said Harry. "The thing to be done is to get all the air that is in the bell out of it. And that is to be done by means of these pumps," continued he, pointing to two tall cylinders of brass, which stood upon the stand with the glass bell; they communicated at the bottom with a pipe, which opened into the bell. There was a handle, by which, as he told Lucy, she could move the pistons of these pumps up and down.

"Just in the way in which the piston moved up and down in the water pump yesterday," said she. "I see, I see; it is all nearly the same thing, only that this pumps air out, as you said, and the other water. I understand it all perfectly."

"Stay, stay, Mrs. Quick-Quick, you do not understand it all perfectly yet. You

see only the likenesses, but there are differences which you do not see yet, and cannot, my dear Mrs. Quick-Quick, because it takes a great deal more time to see the differences than to catch the likenesses, Mrs. Quick —”

She put her hand upon his mouth before he could repeat the offensive words.

“ Brother, do not call me Mrs. Quick-Quick, and I will be as slow as you please, and I will not tell you of any of the likenesses I see. I will be quite silent, and only nod my head, when I understand ever so perfectly.”

“ Then look at the air pump which is before you,” said Harry, “ and observe what I do. I am going to move the handle which you see at the top, which will raise up one of the pistons. What is underneath the piston ?”

“ Nothing,” said Lucy at first; but afterwards she added, “ I believe there is a vacuum.”

“ True. And what happens directly ?” said Harry.

"Air comes in directly to fill it, I suppose," said she.

"Where does it come from?" said Harry.

"It must come from the bell through this pipe," said Lucy, "which leads from the bell to the bottoms of the pumps."

"Then, when that happens, there is less air in the bell than there was before. Is not there?" said Harry. "Now move the piston down again, and what happens?"

"You would press the air that is under the piston back again up the pipe into the bell," said Lucy, "if there is not a valve at the bottom of the pump that shuts against it, and prevents it from going back. But though I do not see it, I suppose there is such a valve, because you told me that it was necessary in all pumps."

"You suppose rightly, and you remember very well," said Harry. "There is such a valve, and it prevents the air from going back into the bell, when I



push the piston down. But what becomes of the air?"

"It comes out into the open air through the valve in the piston, I suppose."

"Very true. Now I will move the handle again, and repeat the operation. I should have told you, that we are assisted in pumping by the expansive force of the air."

"I do not understand that," said Lucy.

"Yes, you do, my dear, if you will only recollect the experiments papa showed you with a bladder," said Harry.

"Ages ago?" said Lucy.

"Yes, you remember seeing the bladder swell out with the expansive force of the air; and you may recollect, that after blowing in air for some time, when we tried to force in more air we could not; the bladder swelled out so that we could hardly hold its mouth together to tie it."

"I remember it," said Lucy.

"If we had let go the string," said

Harry, "and the mouth of the bladder had opened, what would have happened?"

"The air would have forced its way out," said Lucy.

"Yes; air, you know, will expand, and fill every empty place. Now I have pumped out all the air that I can from the bell, and now that it is as empty as we can make it, we call it a vacuum, though very accurate people would tell you, Lucy, that it is not a perfect vacuum."

"It will do for me," said Lucy, "and I think I understand the air pump really now. Is there any other difference between it and the water pump, brother? You said there was a difference."

"I did say so, and I will explain to you what it is, if you will answer my questions patiently. What was it in the glass water pump that you saw yesterday, that pressed up the water into the vacuum below the piston?" said Harry.

"It was the outer air; the weight of

the outer air pressing upon the surface of the water that was in the tub, forced the water up into the tube."

"True; the same in all water pumps," said Harry. "But here is no water for it to press upon. How then is this vacuum filled?"

"By the weight or force of the air itself only, I believe," said she.

"What air?" said Harry.

"It must be the air in the bell," said she, "for I see no other. But that is so little that there cannot be weight enough in that."

"No," said he, "it is not by *weight* that this pump acts, but by the *springiness* of the air itself. This is the difference which I wanted you to observe, between the air pump and water pumps."

"By the *springiness* of the air?" said Lucy.

"Yes," said Harry, "you felt the force of that springiness in the bladder when it was full of air."

Lucy said she should like to feel it

again. She had almost forgotten it. Harry blew into a bladder, and filled it with air, and when it was full bid her try to press it together ; when she tried to do it she perceived the sort of resistance that it made, and she felt the force with which, after she had squeezed it, it returned to its former place and form.

“ The same springiness,” said Harry, “ or what is called the elasticity of the air in the bell, is what fills the vacuum below the piston, each time it is drawn up. Now here is the description and plate of it in *Scientific Dialogues*, and this is all that you need know about it at present. Stay, I will just look at the print of the air pump in *Rees’s Cyclopaedia*, and see if I have left out any thing that I ought to tell you.”

As he opened the book, and as Lucy saw the engravings, she looked a little alarmed.

“ There seem to be as many different air pumps as hygrometers,” said she, sighing.

“ Do not be afraid, I am not going to

show them to you all," said Harry ; " but now that you know the general principle, you would soon feel it easy, as I did, to understand them."

" Oh no !" said Lucy, " there seem to be such a number of pipes and valves, and little *a*'s and *b*'s, and *p*'s and *q*'s."

" They only relate to the contrivances to prevent the outer air from coming in, while we are pumping the air out of the vessel that is to be emptied, which it is constantly trying to do. One pump is better than another only as it does this most effectually, and most easily, and as it more perfectly empties or exhausts the vessel. By the bye, I should tell you that this glass vessel is called a receiver, and when it is emptied it is called an *exhausted receiver*. I was puzzled at first by those words, *exhausted receiver*."

" Thank you, Harry, for remembering that for me."

" Now, my dear Lucy, you shall work a little at the air pump yourself, as you did at the water pump yesterday."

“Oh thank you, thank you,” said she, joyfully; “there is nothing like working oneself; it fixes a thing so well in my memory. I remember the look and touch of the things much better afterwards.”

While Harry was placing the machine, so that it should be convenient to Lucy, she turned to look at the book of engravings, that lay open on the table.

“How well this air pump is done,” said she. “It is very like my uncle’s; not quite, perhaps. I will take care to mind about the *differences*.”

“This is very like it,” said Harry; “there is no difference of any consequence.”

“If we had not had my uncle’s,” said Lucy, “I think you could have made me understand the air pump quite well from this engraving; that is, after my having seen the glass pump yesterday, and its valve and the piston; but without that I could not have understood it from this representation; because I see here only the outside of a pump. Even though you

had described the valves, and explained them to me ever so clearly, I should not have understood them so well as by having seen and touched them, and moved them myself."

"Certainly," said Harry; "but next to seeing the real thing, these engravings or drawings help one very much. Look, though you see only the outside of the pump in that perspective view, here is the inside of an air pump, all laid open for you. You know what is meant by a section?"

"Oh! yes," said Lucy. "Suppose any thing to be cut in two, what you see inside of each part, when they are separated, is a section. Papa explained that, and showed it to me, when he cut a lemon in two for me. I remember this minute, as well as if I saw it before my eyes, the look of the lemon, with the pippins cut in half, each in their little cells, the cells cut open too; and I remember —"

"Very well, my dear," interrupted Harry, "you remember very well what

is meant by a section, therefore you will understand this plate and this figure. But, Lucy, never be ashamed to tell me if you do not understand; you know I have but just learnt these things myself, and I remember the odd mistakes I used to make, and the puzzles I was in when papa was teaching me."

Lucy looked at the engravings now without alarm, because, as she knew what they represented, they did not puzzle her, and she was not afraid of being tired.

After having looked at the section, she said it made the whole as plain to her eye as if it had been made of glass. Something farther, she said to herself, about a man's having a window in his breast; but either she did not say it loud enough for Harry to hear, or he did not think it much to the purpose, for without attending to it he shut the book, saying, "Now we have had enough of the prints. I thought just now you were very eager to work the air pump yourself, Lucy."

"So I am still," said Lucy; "only it



was not quite ready, and I looked at the prints between times. Now let me pump."

"Pump away; this way," said he, showing her how to hold the handle, and how to move it backwards and forwards, and how she worked two pistons at the same time.

She worked it, but not without difficulty. After she had pumped for some minutes, she found the difficulty increasing, and asked from what this arose.

Harry said, from the resistance made by the pressure of the outward air, which becomes greater as the receiver is more and more exhausted. He took off the receiver, and put her hand over the hole at the top of the pipe, which communicates with the pumps, and bid her move the pistons with her other hand gently. She did so, and felt that part of the palm of her hand, which was over the pipe, drawn in. Her brother repeated, "gently, gently," as she moved the handle. Indeed, soon there was no occasion to say so to her, for she

felt the palm drawn in so as to be quite painful, and she grew red with fright.

"Oh! brother, it hurts me very much; I cannot take my hand away. What shall I do?"

"Stop pumping," said he, "and do not be frightened; there is no danger."

She stopped pumping, and her brother turned a screw, so as to let the air into the receiver. This relieved her hand. She held it up to show him a purple circle all round the inside of the hand.

He pitied it a little—a very little. Lucy thought not quite enough.

"I know," said he, "exactly how much it hurts you, because I have done the same a hundred times to my own hand. My dear, I wanted you to feel as I did myself. There is, as you said, nothing like feeling, to make one remember well. What do you think caused this?"

At first Lucy answered, that she did not know.

"Because you are thinking of the pain in your hand," said he.

"That is true," said Lucy, "but it is pretty well over now. What did you ask me?"

"I asked you what caused that kind of sucking in of your hand into the exhausted receiver?"

She thought for an instant, and answered,

"I believe it was the pressure of the outer air, which was trying to get in at that hole, to fill the vacuum, and which was prevented by the palm of my hand, which it then drove in as much as it could. Well, now I am sure I have *felt* 'the pressure of the viewless air;' and now you must let me repeat the line,

'The spring and pressure of the viewless air.'"

Harry repeated it after her, declaring it was a very pretty line, besides, it had some common sense in it. Lucy had said it quite at the right time, when it did not interrupt him, or any thing that was going on. He was so much pleased with it, that he begged of her to repeat all those lines

again for him; and when they went out to their garden soon afterwards, instead of beginning to dig, he desired her to say the lines once more, for that he must learn them by heart. Thus he learnt from her some of her taste for poetry, while she acquired from him some of his love of science.

In repeating these lines, Lucy observed which of them alluded to the barometer, and which to the air pump. When she had first learned them by rote, barometer and air pump had been so jumbled in her head, that she could not understand them.

“ How up exhausted tubes bright currents flow  
Of liquid silver from the lake below;  
Weigh the long column of th’ incumbent skies,  
And with the changeful moment fall or rise—”

she now knew described the barometer, and the succeeding lines the air pump :

“ How, as in brazen pumps the pistons move,  
The membrane valve sustains the weight above;  
Stroke follows stroke, the gelid vapour falls,  
And misty dew-drops dim the chrystal walls;  
Rare and more rare expands the fluid thin,  
And silence dwells with vacancy within.”

While Harry was learning these lines by heart, Lucy stopped as she prompted the couplet concerning "gelid vapour" and "misty dew-drops," and objected, "I do not understand about misty dew-drops on the chrystal walls. I did not perceive any vapour on the glass bell."

Her brother told her, that these lines alluded to a fact which he had not yet mentioned to her, which his father had but very lately told him, and he was not clear enough yet about it to attempt to explain it to her.

Lucy said she was satisfied to wait; that it was best not to know every thing at once, and pleasant to have something to look forward to. But altogether she confessed, that though the air pump was curious and ingenious, to use the air to drive itself out, yet the water pump she thought a much grander, and a much more useful machine. She thought the air pump was not of any use.

Harry smiled, and answered, "So I thought at first. But, my dear, that was

owing to my ignorance. And when you know more you will find that the air pump is of great use. There are many experiments in natural history, as papa showed me, that could never have been tried, and discoveries that could never have been made without it. For instance, to give you a little peep into the matter, we could never, without an air pump, have known that a guinea and a feather would fall to the ground in the same time, if there was no air to resist the fall of either of them."

"A guinea and a feather! A heavy guinea and a light feather! oh, brother!"

"Very true, I assure you; as you will see one of these days."

"Harry, now I think I recollect I heard this about the guinea and the feather before, or read it somewhere; and something else too about the guinea's making no more noise than the feather when it falls. You will show me this too, will you?"

"I am not sure that I can, Lucy," said Harry. "I tried in this air pump, and I did not find it was so. The guinea fell

on the metal plate here at the bottom, and this plate touches the outer air, and rings, makes a noise."

"I do not clearly understand why it should make a noise when it falls, or why it should not," said Lucy.

"I cannot explain it yet," said Harry; "and I must try the experiment about the noise over again, to make myself sure whether I am right or wrong. I am certain that the feather and guinea come to the ground in the same time, for that experiment I have tried often, and it always succeeded."

"Show it to me now," said Lucy.

"No, not now. But you shall see all this, and a great deal more in time," said Harry. "But, Lucy, how could you say that the air pump is of no use? When you know more about it, you will see how much you were mistaken. You will find, that all we know about the specific gravities, the different weights of bodies, and a great many curious facts about sound, and I cannot tell you how many

delightful experiments and discoveries about the air that comes out of vegetables, and about the growing of seeds and of plants, and other experiments about different kinds of gases, as they are called — I say, my dear Lucy, as my father told me, none of these could have been known without the air pump. And then as to the gases — Oh, my dear, I cannot explain to you yet of what amazing consequence the gases are.”

Lucy opened her eyes, and stood looking, as if she thought she could never admire enough. After a reverend pause, she simply repeated the word “Gases!”

“My dear, do not ask me about them yet. You are a great, great way yet from the gases. But if you are good I will put you into boiling water to-night at tea, and get you on to steam and the steam engine.”

“Thank you,” said Lucy, without knowing clearly what was to happen to her.

“Now let us finish the new road to my garden,” said Harry. “But, before we



go, I hope you will acknowledge the air pump, besides being very ingenious, is as useful as the water pump at least. Hey, Mrs. Lucy, you look as if you were not convinced yet."

"I must wait till I have seen and till I can understand all these things, before I can decide," said Lucy.

"Very provokingly prudent and slow all at once," muttered Harry, striking the stones of the new road with his *pounder*.

"Why brother, how can I possibly say more, when you tell me I am so far from the gases; and I am sure I did not understand a word you said about specific gravities; as to the experiment about the feather and the guinea, I long to see that, with all my heart; and I dare say I shall like the others about sound, and seeds, and vegetables, particularly. But these are all curious experiments for grand philosophers, with your air-pump; they may be useful to your men of science, brother; but what I say is, that the common pump is more useful to common people, every

day. And I do say, that I like those machines best, which are most useful."

All the rest Harry heard patiently or passively, as he went on pounding his road; but when she came to the last words, "And I do say, that I like those machines best which are most useful," he threw down his pounder, exclaiming, "You are very ungrateful, Lucy!" and he wiped his forehead, for he was very hot; but, checking himself, he added, "Ungrateful to the air pump, I mean."

"My dear, I did not mean to be ungrateful to the air pump," said Lucy, surprised that he could grow so warm about it. "I did not mean to affront the air pump, or you: I am sure I did not know you cared which I preferred. What can make you care so much about the pumps?"

"I do not know," said Harry. "But I was vexed because you would not do justice to the air pump, and you gave your opinion against it, without knowing *all*. I thought that you were like that foolish woman, who said to the great chemist,

‘Of what use is all your chemistry, if it cannot teach you to tell me how to take the iron-moulds out of my gown?’ Lucy, I hope you will never be so foolish.”

“Never, I hope,” said Lucy; “and I hope you do not think I ever shall.”

“No, I hope not,” said Harry. “But now I must say for the air pump, there is a use that may be made of it in common every day, in hot weather, to make something that is exceedingly agreeable.”

“What can it be?” said Lucy.

“Particularly with sweet-meats and creams,” continued Harry. “Very good of pine apple, and pleasant of tea; mamma told me, not bad even of water.”

“Do you mean ice?” said Lucy.

“Yes,” said he, “the air pump can make ice.”

“Oh! Harry, I cannot believe that. How can that possibly be done?”

“Go to Conversations on Chemistry, my dear, and you will be answered.”

“Very well, I will go to Conversations on Chemistry,” said Lucy; “but not till I

have dug this bed in my garden, and tied up all my carnations, and fed my white rabbit, and finished drawing the last snake of my head of Medusa, and put by the sulphurs in the cabinet, and practised 'The rising of the lark.'"

"Very little chance indeed, through all that jumble of things, of your remembering Conversations on Chemistry and the air pump," said Harry.

"You shall see," said Lucy; "I have always a good memory for what I wish to do."

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"HARRY, I have done all that I said I would: I have dug the bed in my garden, tied up my carnations, fed my white rabbit, finished my Medusa's snakes, put the sulphurs into their cabinet, practised my rising of the lark, and read and understood all that you marked for me in 'Conversations on Chemistry\*.'"

\* Eighth Edition, vol. i, from page 151 to 160.

"Really! You have done a great deal," said Harry; "much more than I expected. I thought the white rabbit would have made you forget every thing else. And do you quite understand all you have read?"

"I do," said Lucy, "for it is very clear. As I was reading, I thought I saw every thing that was described; and after I had finished, I was more anxious than before, to see the experiment you promised to show me. Will you let me see it now, before I forget what I understand, and while my *head is in it*, as you say?"

"I will show it to you as soon as ever I can," said Harry, "with my father's assistance. He says that I must not attempt to try this experiment by ourselves, because sulphuric acid, which must be used in it, is very dangerous to meddle with. If we dropped any of it on our clothes, it would burn holes in them; and if we were to let a drop fall on ourselves, it would hurt us exceedingly. So take care, Lucy, not to meddle with it."

"I will take great care," said Lucy. "I will look, but not touch."

While Harry went out of the room to his father, who was preparing for their experiment, Lucy talked to her mother about the entertaining account, which she had just been reading, of the method of making ice in India, even in the hottest nights.

"How glad they must be, mamma," said Lucy, "when in the morning they see the ice in the shallow pans, which they leave out of doors during the night! Mamma," continued she, "I think that the Emily and Caroline in this book must have been very happy, seeing all the nice experiments mentioned here, and talking to their mother about them, and learning from her. This Mrs. B. seems to be a very good, kind mother. I should like to know her, if she is really a live person. Is there such a real person as Mrs. B., mamma?"

"Yes, there is, Lucy."

"There is! And are you acquainted with her, mamma?" Lucy asked eagerly.

"I am, my dear."

"You are! And what sort of person is she? Do you like her? Oh! yes, mamma, I see by your look before you speak. You like her very much."

"I do, indeed, Lucy."

"I am glad she is an acquaintance of yours, mamma. I hope I shall see her some time."

"She is more than an acquaintance of mine, she is my friend; and if you deserve it, my dear daughter, I hope that she will some time be yours."

"Oh, brother! What do you think mamma has just told me," cried Lucy, running to meet Harry, who at this instant opened the door, and came in, followed by his father.

"Oh! papa, do you know—"

But observing that her father's hands were full, and that he and Harry were intent upon bringing in the air pump,

she wisely ceased her exclamations, and stopped short in what she was going to say.

"Right to be silent, my dear," said her father, as she stood by without uttering a word, all the time they were preparing to show her the experiment. "It is very troublesome and disagreeable to have little girls, or little any bodies, or great any bodies, talking all the time we are busy preparing experiments."

"Busy and anxious too, you know, papa; for some experiments are dangerous," said Harry.

Lucy had learned from what she had just read, that sudden evaporation produces cold sufficient to freeze in a vacuum, even when the outer air is much above the freezing point. A thermometer was near the air pump, and Lucy looked at it, as Harry desired she would. She saw that the mercury stood at 65 degrees, and she felt that the room was warm.

Her father placed under the receiver a large shallow saucer, filled with sulphuric



acid, and in it a small cup of water, raised on a little stand, with a thermometer in it, as described in *Conversations on Chemistry*.

He asked Lucy if she knew for what purpose the sulphuric acid was put there.

She said that the book had told her, that the use of the sulphuric acid was to attract and absorb what was evaporated from the water, before it is frozen.

"And why should it be absorbed?" said her father.

"Because we want to freeze the water," said Lucy.

"True; but you have not explained to me, why we desire that the sulphuric acid should absorb this vapour."

"Because, papa, that vapour fills up part of the vacuum, and it must be taken away, and the sulphuric acid does this as it absorbs it."

"She understands it," said Harry. "Now we may go on — look, Lucy, at what happens — keep your eyes fixed upon the water."

She did so, and she soon saw little bubbles appearing on its surface.

"It is beginning to do something," said she; "but it looks more as if it were going to boil than to freeze."

"You know," said he, "that before water can freeze it must appear to boil."

"Yes, *appear*; I understand why you say appear. That was explained to me in the book."

"Now it begins to freeze," said Harry, "look at the little spikes of ice."

Lucy saw this, and said it was very curious; but still she did not look quite so much surprised and pleased as Harry had expected, because, as she said, she saw only such tiny spikes of ice. She had imagined, that all the remaining water in the cup would have been turned at once into a solid lump.

Harry had talked to her about pine apple ice, and various other kinds of ice, which were so pleasant to eat in hot weather, and which he boasted that the air pump was so useful in assisting people to

make; but from the tiny spikes she had seen, she could scarcely conceive that a sufficient quantity could be made for this good purpose. Harry asked his mother, if she would give them some cream and some sweetmeat, to make sweet ice-cream; he wished exceedingly to show Lucy, that it could really be done in the air pump. Their kind mother provided them with all that Harry desired; but she doubted that they would be able to succeed, as it was difficult even to freeze water. Harry was determined to try, for he had heard that it was a common practice in London, to make use of an air pump in making ice-cream. His father warned him that he was mistaken, but that he might try, and that he would then find out what his mistake had been.

Harry put the cream into a small tea cup, and Lucy mixed with it their raspberry jelly. They put the tea cup into a larger cup filled with water, and this they placed on a little stand, which rested on a saucer, filled with sulphuric acid, within

the glass bell of the air pump. It happened, as it too often happens to young experimenters, and to old ones also, that their experiment did not succeed. They could not freeze the cream.

They tried to console themselves by eating the cream and sweetmeat. This was, however, but an imperfect consolation to Harry. The honour of the air pump, and his own, were at stake, and he recurred to the subject immediately.

"I suppose my mistake was in putting the cream and sweetmeat into the air pump. I was only told that the air pump was useful in making ice. How they make the ice cream with it, I cannot guess," said Harry.

"I can tell you that," said Lucy, "for I once saw the housekeeper make raspberry ice-cream."

"Have you?" said Harry; "and how did she do it?"

"She put some cream and sweetmeat into a tin cylinder: tin I believe it was, or pewter. And this she surrounded with

a great deal of pounded ice and salt. Then she kept turning and turning the cylinder round, with the cream in it, till at last it was all frozen."

"Oh! oh!" said Harry, "then now I see how it is. The air pump produces ice enough to freeze the cream. That must be the way it is useful."

"But how can it produce it in such quantities as would be necessary? It would be a year, at the rate I saw it going on, with a little cupful of water," said Lucy.

Harry acknowledged this, and they appealed to their father.

He told them, that, for this purpose, much larger air pumps than they had ever seen would be necessary. That consequently a greater vacuum was produced, and more water frozen.

"Then it is true, Lucy, you see, the air pump does make the ice that makes the ice cream, and it is used for this purpose in London. Is not it, papa?"

"Not in London," answered their father; "it is too expensive a process to be of

much advantage in this country; but I believe it has been found useful in India."

"In India! There, Lucy, you see how useful it is, and how far its fame goes," said Harry.

"Did they really send an air pump made in England to India for this purpose?"

"Yes," said her father. "And when we go to London, I will show you Mr. Carey's apparatus for making ice."

"Oh! thank you, father; and I shall really see it made, not in little spikes, but in quantities," said Lucy.

"Now, Lucy, you will acknowledge," said Harry, "that the air pump is useful for common purposes."

"I will; I do," said Lucy.

"And you will have much more to acknowledge on this subject by and by," said her father; "you will see other purposes for common life, to which it is applied."

"Oh! what, father?" cried Harry.

"That I will not tell you now, Harry."



In the evening, before tea time, Harry and Lucy played at spillikens, and afterwards a game of chess, in which Harry was beaten; because he was thinking of something he was going to tell Lucy about the steam engine; and he missed seeing a rogue of a knight that had got so close to his king, that he could not stir without being check-mated.

“Now for the steam engine, which you promised to explain to me,” said Lucy.

Harry was afraid that he could not, and turning to his father, asked him to explain it. But his father desired that he would first try what *he* could do.

“This will be of service to you, Harry, for you will be then certain whether you comprehend it yourself or not. People are never sure they understand any thing perfectly till they have explained it to another. If Lucy is puzzled I will help you out of your difficulty, whatever it may be.”

Harry said he would try, and began with these words:—

“In the first place, a steam engine is a

machine —” There he stopped, and began again with,

“In the first place, Lucy, you must know, that the machine called a steam engine was invented —” He stopped short again, and a third time he attempted it, but he hesitated, and blushed, and turning again to his father, he said, “I cannot explain it before you, father. I am so anxious. It is very odd. I am not the least afraid of you, you know; but I feel so ashamed and anxious. I think I should do it a great deal better if you were not by.”

“Very well,” said his father, laughing; “then either you or I must go out of the room it seems. Luckily for you, I am just going into the next room. Is that far enough off? though the folding doors are open, I assure you I shall not hear you.”

“That will do perfectly,” said Harry.

“But what will you do about mamma? She must stay to make tea,” said Lucy. “Look, here is the urn coming in. Had not you better come out into the hall with me, Harry?”



"No, no," said Harry, "I do not mind mamma; and now I think of it, I want the urn. Lucy, look at the steam coming from the top of that urn; do you recollect, a great while ago, my father's holding a cold plate over the steam coming from the urn?"

"Yes," Lucy said, she remembered it well, though it was a great while ago. She remembered, that the cold of the plate had turned the steam into water again, condensed it. She recollected the drops on the plate, which afterwards ran into each other, and down into little streams, when the plate was sloped.

"Yes," interrupted Harry, "you have recollected enough of that; you are clear then that cold can condense steam, that is, can turn it back again into water."

"Perfectly clear," said Lucy.

"Now recollect another thing," said Harry; "which took up most room, the steam, when it was steam, or when it was turned into water?"

"It took up much the most room when

it was steam," said Lucy. "I am sure, that cloud of steam which you see rising from the tea urn, and which takes up so much room in the air, might, if you held a cold plate over it this minute, be condensed into a few drops, which would not half fill a tea spoon."

"Very true," said Harry; "now do not think any more about that: but do you recollect our talking, a great while ago, about the tea kettle's boiling over, as it is called; and do you remember my saying, that if the top of the tea kettle was screwed down tight, and if the spout was stopped, so that no steam could get out, that I thought the tea kettle would burst?"

"I remember it all," said Lucy; "and papa said, you were very right; and I remember afterwards the bursting and explosion of my chesnuts; and the story papa told us of his pouring the hot lead into the damp elder, to make a pencil; and the fact\* I read about the bursting of a little

\* Scientific Dialogues.

hollow brass ball, in which there was water, that turned to steam, and which caused an explosion, that blew a whole foundry to pieces."

"Then you have some idea of the power of steam when it expands," said Harry.

"To be sure I have," said Lucy; "I know it is terribly great, bursting and killing people, and tearing away! How frightened I should have been, if I had been papa, when he was a little boy, when the lead bounced up to the top of the ceiling. I am sure I was frightened enough when my own horse chesnuts bounced."

"But if this terribly great power," said Harry, "is carefully used, and cleverly used, it will do, as you shall see, the most surprising, and the most useful things; it would raise water high as the house, and higher, from the bottom of the deepest mine: it could raise the weight of this room, and all that is in it, as high as the top of the highest tree, and higher."

"Oh, brother! brother!" said Lucy.

"It is quite true; it can do more in an

hour, than two hundred horses, and fourteen hundred men. It can drag loaded waggons full of coal, such as you have seen going step by step, the horses pulling hard — it can pull these waggons up as easily as I can pull your little cart.”

“My dear brother, how can I believe it!” said Lucy.

“It can drive across the sea, against the power of the wind and the tide, a great ship, with all the people in it, and all their horses and carriages, and all that they have in the world.”

“Is it really possible?” said Lucy. “I have heard people talking of steam boats, and of the working of steam engines; and I remember papa’s asking a gentleman, who was here the other day, whether his steam engine was an hundred horse power. But I never knew how this was, nor could I conceive that steam could do all this by itself. Only steam like that?” said she, fixing her eyes upon the steam that still came from the tea urn.

“Yes, only steam like that,” repeated

Harry. "Think what we men can make it do at our bidding."

"Really and truly, Harry," said Lucy, "it does more at men's bidding than any of the genii in the Arabian Tales, more than any of the slaves of Aladdin's lamp, for the hardest working of them could only be made to carry one house."

"Very true, indeed," said Harry, and for once he was pleased with an allusion.

"But," continued Lucy, "I should be very much afraid of its doing some great mischief some day, like the African magician. Do you remember?"

"But, my dear," interrupted Harry, "do not tell me any thing more about the African magician."

"Only this one thing, Harry, if you would let me get it out of my head, I should attend so much better."

"No, my dear Lucy. Is it not very hard upon me, that you are to say every thing that comes into your head, and that puts out of mine all that I want to remember about the steam engine for you?"

"I beg your pardon," said Lucy, "I will not say a word more of the African magician. Go on."

But poor Harry could not go on immediately. "Where was I?" said he to himself. "What was I going to say?" As he spoke he rubbed his forehead first, and then ran his fingers through his hair from the roots upwards, till it was all pushed up, and stood erect, "like quills upon the fretful porcupine."

"Now I recollect what I was going to say," cried Harry. "Look at the tea urn, Lucy. Ah! but now it is too late; there is not steam enough—it is not strong enough to do what I wanted you to see. But at first, when the water was boiling, and the steam rushing out at top, you might have seen it pushing up the lid of the urn, till the steam got out, then the lid fell, and lay still till more steam was formed, and pushed it up again. I wish you had seen it going up and down."

"I have often seen it," said Lucy, "and watched it moving; because sometimes I

was afraid the top would be quite lifted up, and blown off."

"And so it would," said Harry, "if it were not for these little holes, look here, through which the steam escapes, and which were made on purpose to let it escape, without blowing off the top, or doing any mischief."

"That is very prudent; I am glad the holes are there," said Lucy.

"But suppose they were not there," said Harry, "and the top left loose as it is now. If the water boiled *well*, as people say, if a great deal of steam came rushing up, and pushing out through this place where the top goes on, you know the top would be lifted up. And suppose I lay on the top this weight," continued he, taking up from the table a small weight, which was used for keeping down papers; "and suppose I put a lamp under the urn, so as to keep the water boiling, and sending up fresh steam, what do you think would happen then?"

"I am not sure," said Lucy, "It would

either burst the urn, or lift up the top with that weight upon it. It would, I am sure, lift up the top and weight, because that would be the easiest way for the steam to get out."

"To be sure. It would require much less force," said Harry, "to lift this little weight than to burst the urn. The expansive force of steam, you know I told you, would lift the house. Now suppose that, instead of that urn, with a little lamp under it, there was a great fire, as large as a kitchen fire and larger, and a great iron boiler, as large as the boiler you have seen in the kitchen and larger, with water boiling in it; and over the mouth of that boiler suppose we put a cylinder like the body of a pump, as large as that in the yard, and closed well round at the place where it is put in, so that the steam of the boiling water can get out no way but up the cylinder."

"Then," said Lucy, "how the steam would rush up through the valve in the



piston ! What a cloud of steam would come out at the top !”

“ Stay, stay, Lucy ; I was going to have told you, that in this piston there is to be no valve, it is to be a tight stopper. Now suppose, before I let the steam in, that I have the piston down at the bottom of the pump.”

“ Why then, before you let in the steam you must put a great weight to keep the piston down, or it would be thrown up to the ceiling, as the lead in papa’s pencil case was.”

“ And I believe,” said Harry, “ your great weight would be thrown through the ceiling, and would break it to pieces. Consider, my dear, if the small quantity of water, that was in papa’s elder pencil case, could, when turned into steam, force the lead up to the ceiling, and if the small quantity of water that was left in the little brass ball could burst, and blow up a whole foundery, such a quantity of steam as this would be able to lift up

and blow up this room, and all that is in it."

"But if that is your only way of lifting great weights, and of lifting the house, I do not see how it can be useful."

"Patience, Lucy. Suppose that we know beforehand the weight of whatever we wish to lift, we can calculate and lessen the fire, and lessen the steam, till it is just enough, and no more than enough, to lift the weight gently up, to whatever height we please—suppose now to the top of the pump. Then you do no mischief, you see."

"Very well," said Lucy, "if you can calculate exactly, and make no mistake. That is very nice."

"But now suppose you want to do this more than once; to lift several weights, one after another—could you do it? You have the piston and the weight up at the top, and the steam in the cylinder of the pump."

"I do not know," said Lucy; "for I

dare not take the weight off the piston. I dare not touch it."

"I would not advise you to touch it indeed," said Harry.

"Then what can I do?" said Lucy.

"Think," said Harry.

"But the idea of the steam going on, coming up through the pump, frightens me. I will tell you what I would do; I would put out the fire directly, throw water upon it."

"Very well thought of," said Harry, "but then there is steam in the boiler."

"I would throw water into that if I could, but I cannot get at it. I would throw cold water all over the outside, and that would cool the steam."

"But still there would be the steam in the body of the pump," said Harry.

"And I cannot throw water into it because of the stopper," said Lucy. "Well, I will throw cold water over it, all down the sides, and over the piston at top, and cool it, and make it as cold as the plate

papa held over the urn, and colder ; then it would condense the steam within, and turn it into a very small quantity of water."

"Then what would happen?" said Harry.

"The piston would fall down—there would be nothing to hold it up. The steam would be all gone."

"And what would there be, or would there be any thing in the place of the steam?" asked Harry.

"There would be nothing but a little water ; there would be a vacuum, all but those drops of water," said Lucy.

"Very well, indeed," said Harry. "Now you have the piston down, how will you raise it again? I want to have another weight brought up."

"Then, you know, I must light the fire, and boil the water again," said Lucy.

"Aye, and wait till the cylinder is heated too ; for, till that is heated, it will condense the steam," said Harry.

"Certainly," said Lucy, "you must wait till it is hot."

"But it would be very inconvenient," said Harry, "to wait while you light the fire, and boil the water, and so on. Cannot you find any better way of condensing the steam, without putting out the fire every time?"

Lucy thought for a few moments, and answered, "Perhaps, without putting out the fire, it would do as well if I could but let cold water into the boiler, and into the cylinder of the pump."

"But why into the boiler," said Harry.

"Because the fresh steam would come up continually if I did not prevent it," said Lucy.

"But suppose," said Harry, "you have condensed the steam in the cylinder, and you only want the vacuum for an instant or two, just to let the piston fall; and suppose that for that little time the steam from the boiler could be prevented from coming in; I need not tell you how, but it can."

"Then I need not put out the fire, but I may condense the steam in the

cylinder," said Lucy; "that will be much more convenient, because afterwards the steam will be ready to be let in again, under the bottom of the piston, if you want another weight to be sent up. But still I do not know how to get the cold water into the body of the pump, I mean into the cylinder, to condense the steam."

"The steam," said Harry, "is let off into a separate vessel, called, from its use, a condenser. This vessel is surrounded by cold water, so that the steam is condensed, as soon as it comes into it."

"And is this all the steam engine?" said Lucy.

"No, my dear Lucy, it is only the general principle. I cannot explain all to you, I should only puzzle you. There are different sorts of steam engines. In that invented by Mr. Watt, the expansive force of the steam is used in different degrees, to raise the piston, and to force it down."

"I did not know that the steam was ever let in above the piston," said Lucy.

"Yes, it is. I did not tell you that at first, lest I should puzzle you, and I will not now tell you exactly how it is done. And there is a great deal more to be explained, about the ways of making the steam engine raise weights, or water, or work machinery, in different directions. Ours was but an awkward way of raising weights, by putting them on the top of the piston. Suppose I want to raise water from a pond, you must put a beam out from the top of the piston, like a scale beam, and with this you might work the piston of a pump fastened at the other end of this beam."

"Very convenient!" said Lucy, "and very simple."

"There are a great many other contrivances," said Harry, "and ways of making it turn wheels, and pull and push sideways, or in any direction in which you want to have work done, or force

applied; but I should tire and puzzle you to death if I were to tell you all at once. Papa took several days to explain to me the parallel motion, and the fly wheel, and the sun and planet motion, and the excentric."

"Oh, my dear brother!" cried Lucy, stopping her ears, "this would puzzle me to death indeed."

"Therefore, my dear, I tell you, I will not say one word about any of these things to-day, but I will leave your head quite clear, as I hope it is, in the general principle, as papa calls it. And here he comes with his letter in his hand."

"Mamma is beginning to pour out tea," said Lucy, "let us go to her."

"Stay one minute, Lucy," said Harry. "Now, pray, when you are called upon to explain to papa, be quite steady. Do not be a coward, and fancy that you do not know what you do. And do not be too quick neither. Above all do not go the least beyond what you really know. Do not put in any of your '*It's like this,*'



or '*It's like that.*' When you have no more to say, stop."

"I will," said Lucy. "I will not say one word more than is necessary, nor make one allusion or quotation. I will be like your own dear Menelaus: I'll say no more than just the thing I ought."

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"Now, papa, will you ask Lucy to explain to you what she knows of the principle of the steam engine," said Harry, walking up with her to the tea table, with a composed countenance.

"First, Harry," said his father, "I must ask your mother to read this letter for me, and I have a great deal to say to her about it."

Harry sat down with a resigned look, and swallowed tea, and eat bread and butter, without hearing one word of what was going on, till at last his father turned to Lucy, and said, "Now, my dear, I am ready for you and the steam engine."

Lucy, who had been listening to the letter, declared she was afraid that the whole of the steam engine had gone out of her head.

In astonishment Harry stared at her, and, in a tone of indignation, exclaimed, "Is it possible, Lucy?"

"Stay, do not frighten me," said Lucy, "and perhaps I may get it back again."

She did, and she recollected all Harry had said to her; she distinctly said "no more than just the thing she ought." Her father was doubly pleased by the clearness with which she made her explanation, because it showed that Harry had understood well what had been taught him.

"I promise you both," said he, "that, the first time I have an opportunity, I will show you a steam engine."

Harry was delighted with this promise, and Lucy clapped her hands, and added, "I know, Harry, that the opportunity will come soon."

Harry was going to ask her how she knew this, but his attention was taken

off by his father's observing to him, that he had done well to refrain from describing to his sister any of the lesser parts of the machinery.

Lucy said, "It was not at all difficult to me, papa, for he brought me up to the steam engine by degrees, and I was quite surprised when I found I was at it. I did not know what he was about when he began with your cold plate, and the tea urn, and the expansive force of the steam, and the condensing the water; but I saw plainly afterwards, when I found out where I was. It was just like his way of leading me blindfold on the gravel walk, and taking me to this place and that; and I do not know where I am, or where he is leading me, till he takes the bandage off my eyes, then I am quite surprised at what I see before me."

"Ha! ha! Lucy, I thought you could not get through without an allusion," said Harry. But he was well enough pleased with this. His spirits were so much raised by this commendation, and by the promise

of seeing a steam engine, and a steam boat, and by Lucy's success and his own, that he could not refrain from saying a little more than just the thing he ought. He would now go on to tell her the names of the first, second, third, and fourth inventors and improvers of the steam engine. But he was fortunately stopped by his father's getting up to look for a book, in which, he said, he could find a poetic description of the wonders performed by the expansive force of steam.

"Oh, I know that book," said Lucy; "it is the same, Harry, in which there are the lines on the barometer and air pump."

"The description of the steam engine," said their father, "begins by doing honour due to him, who

'Bade with cold streams the quick expansion stop,  
And sunk the immense of vapour to a drop.'

Who was that, Lucy?"

"The inventor of the steam engine, the man who first thought of throwing

cold water upon it to condense the steam," said Lucy.

"Savary, or the Marquis of Worcester, I do not know which," said Harry. "You know, father, there have been many disputes for the honour of this great invention."

"Yes, but let these rest for the present, Harry," said his father. "Savary is the person alluded to in these lines."

"Do go on reading, papa," said Lucy. "I like those lines so much."

Her father continued :—

"Pressed by the ponderous air, the piston falls,  
Resistless sliding through its iron walls,  
Quick moves the balanc'd beam, of giant birth,  
Wields its large limbs, and, nodding, shakes the  
earth ;

The giant power, from earth's remotest caves,  
Lifts with strong arm her dark, reluctant waves,  
Each cavern'd rock and hidden depth explores,  
Drags her dark coals, and digs her shining ores."

"Yes, I understand," said Lucy ; "that describes the steam engine, bringing up water from the bottom of mines, and drag-

ging the coal waggons, as Harry told me it could."

Her father went on reading :—

" Next in close cells of ribbed oak confined,  
Gale after gale he crowds the struggling wind,  
Th' imprisoned storms through brazen nostrils roar,  
Fan the white flame, and fuse the sparkling ore."

" The great bellows in forges and founderies, which are moved by the steam engine," said Harry. " I never should have thought they could have roared so well in poetry. Pray go on, papa."

" Here high in air the rising steam he pours  
To clay-built cisterns, and to lead-lin'd towers ;  
Fresh through a thousand pipes the waves distils,  
And thirsty cities drink th' exuberant rills ;  
These the vast millstone, with inebriate whirl,  
On trembling floors his forceful fingers twirl,  
Whose flinty teeth the golden harvests grind,  
Feast without blood, and nourish human-kind."

" Do you understand, Lucy?" said Harry.  
" I forget, my dear, whether I told you,  
that the steam engine keeps corn mills  
and all sorts of mills going."

Lucy nodded. " Do not let us interrupt papa ; I will tell when I do not un-

derstand," said Lucy, "but I understand all as far as he has gone."

"Now his hard hands on Mona's rifted crest,  
 Bosomed in rock, her azure ores arrest;  
 With iron lips the rapid rollers seize  
 The lengthening bars, in their expansion squeeze;  
 Descending screws, with ponderous fly-wheels wound  
 The tawny plates, the new medallions round,  
 Hard dies of steel the cupreous circles cramp,  
 And with quick fall his massy hammers stamp  
 The Harp, the Lily, and the Lion join,  
 And George and Britain guard the sterling coin."

"Lucy, I am sure you cannot understand this," said Harry.

"No, I was just going to say so, Harry; I waited only till papa came to a full stop. But I know that Mona means Anglesea."

Her father said that she was right; that the azure ores allude to copper mines in the Isle of Anglesea, or Mona, which are worked by the steam engine. *Cupreous* means *of copper*, and the ores of copper being blueish, the poet calls them "Mona's azure ores." The succeeding lines describe machinery for coining copper, first rolling out thick bars of it into plates, thin as half-

pence, then cutting those plates into circular forms, and stamping them with the arms of Ireland, France, and England, the harp, the lily, and the lion. All which is done by machinery, without the hands of men, and that machinery is kept at work by the motion and power of a steam engine.

Harry looked triumphant while his father spoke of these wonders performed by steam. Lucy could not conceive how it could do all this. Her father repeated his promise, that whenever he had an opportunity he would show her how it is done ; and Lucy whispered again to Harry, "Very soon, too, perhaps."

"Is there no more, father? Is there nothing about the steam boat?" asked Harry.

"There is," said his father ; "and it is curious, that these lines were written several years before steam boats had been brought into use ; and at a time when it was scarcely believed by any but a few courageously ingenious persons, that the steam engine could ever be successfully or safely



employed in driving forward vessels on the water. This prophecy, at the time it was made, most people thought merely poetical; and instead of expecting that it would be *soon* accomplished, it was thought that it would never be effected : —

‘ Soon shall thy arm, unconquer’d steam ! afar  
Drag the slow barge, or drive the rapid car.’ ”

“ The *slow* barge now goes as fast as you please,” said Harry. “ The rapid car is to come ; and I dare say that will be accomplished soon, papa, do not you think it will ? And oh, father, read this ; here is something about a flying chariot, which we did not hear :

‘ Or on wide-waving winds expanded bear,  
The flying chariot through the fields of air.’ ”

His father had purposely omitted to read these, and prudently declined giving his opinion.

Harry became silent and thoughtful for some minutes, but occupied himself with burning a lump of sugar, whose amber drops, as fast as they fell and cooled, he put into Lucy’s mouth. And when the

sugar bason was taken from him, he found new recreation for his fingers and thoughts in his mother's tambour needle, which he pushed and pulled up and down, through silk and through paper, till she took that from his hand, and then he had no resource but to lean with both his elbows on her frame, and to watch her plying the needle. Lucy whispered from time to time—

“Will not you come and play at ‘*Travellers*’ with me?”

But in vain she twitched his elbow, it remained fixed.

“My mother’s work is like a chain,” said Harry; “link within link—loop within loop.”

“Yes,” said Lucy, “it is called chain stitch.”

He watched the lengthening chain, which, with the quick noise of successful pricks, advanced towards him, forming a line from one end of the frame to the other, which was accomplished in two minutes, counted by the watch. Then scallops and leaves, pointed and round, grew

under her hand. Nothing too difficult for the dexterous hooked needle.

"It goes on so easily," said Harry, "it seems to do it of itself."

"And do you think you could do it, Harry, as mamma does? Mamma, pray let him have the needle and try."

Harry had little doubt that he should succeed, if he might be allowed to try, because he had most carefully observed all his mother did; he had watched her hand under the frame, and had seen, as he said, how, by a little quick motion, she hung the cotton or silk, whichever it was, over the hook of the needle, and then pulled both up together through the muslin, exactly through the middle of the last link, and then dragged on a new loop, with a little twitch and twist; and down again with the needle.

"Well observed, and accurately described, I grant," said his mother; "you are perfect in the theory, but now for the practice."

She put the tambour needle into his hand, the feeling of which he liked par-

ticularly, because its ivory handle was as large as a pencil case, and something fit for a man to hold.

"Now we shall see how the man will work tambour work," said Lucy. "Aye, down goes the needle, pop through the muslin, easily enough; but now get it up again, and the silk with it, if you please and can."

Harry turned the ivory handle to this side and to that, and leaned it this way and that way, and twisted and double-twisted the silk on the hook beneath; and twitched, and plucked, and pulled in vain, and came to "Pooh!" and "Pshaw!" and "Do not look at me, pray. I cannot do it if you look at me."

"Nor if we do not look at you," said Lucy.

"I have done it!" said he, dragging up the needle by main force, and making a hole in the muslin through which he hauled it.

"Oh, Harry! what a hole!"

"I do not know how it happened," said Harry, "but the needle is up at any rate,

and the loop with it ; and I have one link of the chain, what you call one stitch, and now for the next, which you see I will do better."

He tried again, but the hole made it impossible ; he pulled out his first, his only stitch, and tried again in a fresh corner. Nothing ever did try his patience, or, as he thought, nothing ever did try human patience so much. But, by taking thought, he did get the needle and the loop safe through this time without tearing the muslin. He persevered, and in a quarter of an hour had really worked a quarter of an inch of chain, all crooked, dragged out, short and long links of various sizes. Sad chain-stitch, as Lucy called it, but still she could not deny that he had done it. His fingers were so hot that he spread them out to cool, and groaned, and took breath, as his father said a coal porter might do, after setting down the heaviest load.

His father next took the needle in hand, with a theory as perfect, with somewhat more diffidence, but with little better suc-

cess. There was a knack in it, which could be learned only by practice. But the gentlemen talked very learnedly to each other about it, and agreed that their perfect theory had helped, would help, or should have helped, them very much.

"But how wonderfully quickly my mother does it," said Harry. "Do it again, mamma, pray. How can you go on so quickly with the work?"

"You think I go on quickly," said his mother, "but all that I could do in a day could be done by a machine, Harry, in an hour. And by what machine, do you think? By your dear steam engine! This is a use for it of which you never thought."

"Is it possible?" cried Harry.

"Can these *ins* and *outs*, and all this delicate work, and these pointed leaves, be all done by a steam engine?" said Lucy.

"A huge steam engine!" said Harry.

"Mamma, how I should like to see it at work, doing the tambour work," said Lucy.

"Perhaps I shall be able to show it to you, my dear," said their father.

"And soon," whispered Lucy to her brother.

"What can you mean?" said Harry. "I heard you say, *and soon*, over and over again."

"My dear, did not you hear the letter, and all papa and mamma were saying about it?" said Lucy.

"Not I," said Harry.

"You were sitting at the tea-table all the time, beside me," said Lucy.

"Very likely," said Harry; "I did not hear a word that was said."

"What could you be thinking of?" said Lucy.

"I do not know," answered Harry. "Of a bell crank, I believe. When I saw mamma pull the bell cord, I thought I would show you the bell crank in the passage to-morrow, and explain by that the crank motion in the steam engine."

"How full your head must be of this steam engine," said Lucy.

"And of you, Lucy, my dear; I was thinking of something to show to you."

"Thank you," said Lucy; "then I will now tell you all that I heard, that you did not hear. The letter was papa's answer to Sir Something Somebody, the man, the gentleman, husband to the lady who told of the shipwreck, when she called here the morning that I spotted my gown with the dirty water from the pump and pond."

"But never mind that now," said Harry; "get on, my dear, I want to hear what is to come."

"Papa's letter was to thank that gentleman for the trouble he has taken in looking for a house somewhere, a great way off, by the sea-shore."

"And why did papa thank him for that?" said Harry.

"My dear Harry, you are so slow in understanding," said Lucy. "The house is to be for papa and mamma; and if there is but room enough in it for us we are to go with them."

"You do not say so!" cried Harry, starting upright with joy.

"I do say so. I heard it with these ears,



and very good ears they are," said Lucy ;  
"and papa told me I might hear. His letter said, towards the end of it, ' I hope there may be two little rooms for Harry and Lucy, their mother and I wish to have them with us.'"

"How kind ! Oh ! any sort of little rooms—any little dens would do," said Harry. "I could sleep in a drawer—in a nutshell ! Could not you, Lucy ?"

"To be sure," said Lucy. "But if they cannot in any way find room for us, we are to be left with my uncle."

"Oh !" cried Harry, uttering something like a groan, "I hope we shall not be left with my uncle, though in general I like to be with him very much ; but I never went a journey, a long journey, and with papa and mamma ! Lucy, think how delightful it would be ! to see mountains, and go up them with my portable barometer."

"And to be by the sea side," said Lucy. "I never saw the sea, and I shall pick up shells by the sea shore—beautiful shells, and sea weed, and sea urchins ; and we

shall live in a cottage. Oh! think of living in a cottage!"

"And we shall see a steam boat, and a steam engine," cried Harry; "now I understand it all. But remember, it is not certain yet that we are to go, Lucy. I will not think of it any more, lest we should be disappointed at last."

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"Joy! joy! joy! for you, Harry; joy for both of us!" cried Lucy. "The great black trunk, and the little black trunk, and the seat-boxes, and the carpet bag, are coming down from the garret to mamma's dressing-room. Packing up is beginning, and we are to go."

"We! But are you certain, Lucy? How do you know," said Harry; "I should not like to be disappointed, my dear."

"Who would?" said Lucy. "But no danger, my dear Harry; I heard the answer to papa's letter, and it says that there is room for us. Only, that one of us must be

put in a very little closet, which can just hold a bed and a chair."

"I do not care how small it is, if I can but be crammed into it," cried Harry.

"Nor do I," said Lucy; "I can sleep on a sofa, or anywhere, so that we may both go."

"If we do not both go, there will be no joy," said Harry.

"But I tell you we shall both go. Mamma says she can manage it. They are to set out the day after to-morrow, at six o'clock in the morning. And I asked mamma," continued Lucy, "if I might pack up your things and mine to-day, in the little black trunk. She says I may, if I can; only she is afraid I cannot do it well enough; but I think I can. Bring me directly, Harry, to the dressing room, all the things you want to take with you, and I will get all mine in a minute."

Presently two great heaps appeared on the dressing-room floor.

"There are all my goods," said Harry, pointing to one heap. "All these must go."

"And here are mine; I hope they will all go in," said Lucy, looking doubtfully at the little black trunk, which stood between them.

Harry, pressing his hand down on Lucy's heap, observed, that "they could be squeezed almost to nothing. Cram my things in any way," said he, "I do not care how, so that they go — only make haste — I will go and finish my Latin lessons, and be back by the time you are ready to lock the trunk. Ram my things any way, my dear," repeated he, as he left the room.

"Mamma is to see how the trunk is packed, when it is finished," said Lucy, "and I must do it well."

She packed, and packed, and squeezed, and crammed, and rammed, but in vain; she could not get in above half of these things.

Then she took out of the trunk all she had put in, and by her mother's advice began to sort her brother's and her own into two classes, of *necessaries*, and *unneces-*

*cessaries.* By this operation, her brother's heap was diminished above two-thirds, and her own nearly half. When Harry returned, he was not at all contented with her arrangement; and, to satisfy him, she gave up several of her books, and reduced her portion to exactly the same size as his. Harry left her to pack the trunk; and this time, having listened to her mother's advice, to lay each thing, as she put it in, as flat as possible, and to leave no holes or hollows, she succeeded in putting in all things necessary. There was one luxury of her own, which she much desired to carry. It was a pasteboard tray, that was made for holding shells. She emptied out all its contents, that she might fill it with a new collection from the sea shore. To her great satisfaction, there appeared just room for it, at the top, in the arched lid of the trunk.

Her mother was called to see how easily it locked, and she examined the packing, and pronounced, that it was as well done as could be expected from so young a

packer. She ran to report her success to Harry, and to summon him to see how nicely her shell tray lay at the top of all the things, fitting under the arched roof of the trunk. She met him coming up stairs with a huge book, as she thought, under his arm; he asked eagerly if she had finished packing the trunk.

"Quite finished," said she; "come and look at it, and you shall lock it yourself."

Harry looked disappointed, and said, that he was very sorry the trunk was quite full, because he had found something else to put in, which he wished particularly to carry with him, and his father had just told him that it must not go loose in the carriage.

"What is it?" said Lucy: "fetch it; if it is not very large, perhaps I can squeeze it in."

Harry, half ashamed to ask the question, said, "Could you get in what I have here under my arm?"

"This immense quarto book, Harry! Impossible!" cried Lucy. "It is as large as half the whole trunk."

"It is only a false book, my dear," said Harry.

"False or true, that does not make it less," said Lucy.

"But, as it opens," said Harry, "and has an almost empty inside, it will hold a great quantity. It will take up scarcely any room in the trunk, only the thickness of its own sides, and they are of very thin wood covered with paper. Do, my dear Lucy, try if you can get it in. It is a camera obscura, which my uncle has just given to me."

"Indeed!" said Lucy. "Well, my dear, I will try my very best."

But, on opening the false book, she observed that it was not nearly empty, that there was some apparatus withinside of it, which took up a great deal of room. She saw especially a glass, which she was afraid would be broken, if she put any thing withinside. He urged her, however, to try. If it were packed with soft things, such as her frocks, all would be safe. "If we can but carry the camera-obscura with

us," said he, "when we get to any pretty country, and to the cottage by the sea side, we shall see such beautiful landscapes in it, and the boats and ships sailing. Oh! do Lucy, contrive to carry it."

"I will give up my shell tray," cried Lucy, "and then I can make room for it perhaps."

"There is a dear good girl," said Harry.

She ran, and he followed her to the trunk. He saw how nicely the tray fitted, and he saw her take it out, and put it quite away; he heard a little sigh as she locked the closet door upon it, after putting it out of sight.

"My dear Lucy," said he, "I cannot bear that you should give up your tray; I dare say you wish to carry that and your shells, as much as I wish for my camera obscura."

"Never mind," said Lucy.

"But I do mind, and the more because you do not," said Harry.

"But I will tell you why you need not care so much, Harry," said Lucy; "I can



make another tray of pasteboard easily, when we get to our journey's end, and that will be time enough for my shells at the sea shore; but you, Harry, could not make a camera obscura."

"Very true," said Harry; "thank you. But you have all to unpack, which you had packed so neatly."

"Never mind," repeated Lucy, "if I can but get it in."

"You need not unpack to the bottom: stop my dear," said Harry. "The camera obscura is only about one-third of the depth of the trunk."

In it went, and there was a little space at its ends, and beyond its breadth, into which things could be crammed, and should be crammed, as Harry observed, to keep it tight. The greatest trial of Lucy's patience, was his standing by all the time she was repacking, advising all the while, and saying, as she put in each thing, "That will not go there," or "This would fit better," &c. After she had, to the best of her skill, repacked the trunk, there re-

mained on the floor a new jacket and trousers of Harry's. The jacket, too, was covered in front with innumerable hard sugar-loaved shaped buttons, which took up a terrible quantity of room, and which could not be compressed. Harry would have found an easy remedy, by leaving jacket and trousers and all behind. He thought he could do perfectly well without them. So did not his mother; upon appeal to her, she decided that they must go. What was to be done? Harry, though it would give Lucy a great deal of trouble, thought he saw how it could be managed.

"I do not mind the trouble," said Lucy, "if I can succeed at last; but I think it is really downright impossible to get more into that trunk, without breaking the hinges in squeezing it down."

Harry suggested, that if Lucy would unpack the whole trunk, and put the camera obscura at the bottom, perhaps she could get in more, because his jacket, with its hard buttons, might then lie at the top, as her tray had lain, under the curve of the

top of the trunk: by having the flat box uppermost, some of that space he thought was lost.

Lucy was not quite clear that he was right; but, however, she, in a most obliging manner, began to unpack the trunk again, and said she would try it *his way*.

All of any age, who have a good opinion of their own powers of packing; and who has not? will give Lucy more credit for this than for all the rest. She gave up her own opinion, and repacked upon her brother's suggestion, with as much zeal and alacrity as if it had been an idea of her own. We are happy to state, that this time she succeeded in putting in what was required, camera obscura, jacket, trowsers, and all, to Harry's joy and admiration.

Her mother was pleased.

"My dear little girl," said she, "I am glad to see, not only that you are good-natured to your brother, of that I did not doubt; but I am glad to perceive, that you are good-humoured too. Good temper is necessary, even to the most good-

natured people. I have often seen good-natured people more ready to make great sacrifices than little ones for their friends; but the little ones are most frequently wanted, especially from women, almost every day of their lives. And if they make these in a good humoured, obliging manner, as you, Lucy, did just now, they will be beloved, and, as far as they can, will make the friends they live with happy."

"Yes, mamma," said Lucy, "as you do. You came into my head when I was unpacking the trunk for Harry. I recollected your unpacking the great trunk one night at Coventry, when the maid was out, and you were tired to death; and aunt Pierrepoint wanted something, which she said was at the bottom of the trunk: and it was not there after all. Mamma, I recollect another thing: one day, when you gave up going to Warwick Castle, which I know you wished very much to see. Well, mamma, on this journey, which we are going to take, you shall see, that if I have any trials, I

will be as good — I mean in proportion," said Lucy.

Harry at this moment returned to the room with their hygrometer, and its register, in his hand; he told Lucy, that he thought it would be useless for them to keep the register while they were travelling, as they should change every day to different parts of England, and it was a register of the weather in one place that was required. Lucy was glad he had found out that it would be useless: she was sure that it would have been impossible for them to keep it, while on their journey; and she felt relieved from a great responsibility, when Harry determined to leave it with their uncle, till their return. Lucy further observed, that it would also be impossible, she feared, to go on regularly with Harry in his course of scientific lessons, for which she was really sorry, though the pleasures of travelling, she acknowledged, might make up for this interruption.

"Yes," said Harry, "that is true; we

must give up our regular lessons till we come back; but, as papa has just been telling me, it will do us both a great deal of good, and me in particular, to see new things."

"Delightful!" said Lucy; "and thank you, papa, and thank you, mamma, for thinking of such a pleasant way of doing us good."

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At six o'clock in the morning, Harry and Lucy were seated opposite to their father and mother, in an open carriage; bags, books, parcels, nicely packed in, and Harry's portable barometer snug beside him. "Drive on."

The young travellers stood holding *by something* no doubt, according to the ever repeated and never-to-be-too-often-repeated counsel. They looked from side to side as they passed, bidding good-bye to each well known object, half sorry to leave home, yet glad to go on to something new. It

was a fine morning, the sun shining, the air fresh, and

“ ————— Herb, tree, fruit, and flower,  
Glistening with dew.”

Their way led through a lane, the hedges on each side full of honey-suckles, with white and pink bind-weed straggling above, about, and underneath. The ground under the hedges was covered with wild flowers of many colours; abundance of that most delicate weed, if weed it should be called, which paints the banks with blue, well known to all the world by one name or other; to the unlearned as speedwell, to the learned as *veronica chamædrys*; there was also abundance of that erect plant, with its spire of crimson bells, spotted or plain, by peasants *fox-glove*, by botanists *digitalis* called, valued by the old as a cure for the dropsy, and loved by the young, for the loud pop! pop! pop! which in skilful hands can be made by its flowers. Harry asked Lucy if she knew why the fox-glove is called *digitalis*.

“No,” said Lucy, “why?”

“Because *digitale* is the Latin for a finger of a glove,” said Harry.

“And the shape of these bells is very like the finger of a glove,” said Lucy; “but why *fox-glove*? foxes do not wear gloves.”

Their father said, that perhaps it might have been called so from growing in the haunts of foxes.

When they came to the end of the lane, and the road opened to the view of freshly mown meadows, and extensive corn fields, Lucy exclaimed,

“Look! look! Harry, at the gossamer glittering in the sun, all over that field, as far as we can see. Do you see it waving up and down with every breath of wind. Pray, mamma, look at this immense cobweb net, all spangled with dew. Is it not beautiful, most beautiful, Harry?”

Harry answered, “Yes;” but it was ayes uttered in a cold tone, which did not satisfy Lucy. Yet he looked at the gossamer earnestly. But he was always more curious about the causes of whatever he saw, than pleased by their appearance. While



Lucy had been admiring the glittering, floating, waving net, Harry had been considering how, or by what this net was made. Lucy said, that in her favourite book of insects\*, and in other books, she had read something about gossamer. He begged she would tell him all she knew of it directly.

And as fast as she could she told him, that all these shining threads are made by a very small insect, the garden spider, who, like other spiders, can throw out from their bodies a sort of glutinous substance, which hardens in the air. Some say, that the spider leaves the threads behind him, as he darts through the air in search of food. Others say, that he has the power of throwing it out before him, and that it catches upon the blades of grass, or on the rough edges of leaves and bushes, and then being pulled tight by the animal, forms as it were a bridge, or road in the air, for him to pass from place to place. He has been called by some people the flying

\* Dialogues on Entomology. Rees' Cyclopaedia.

spider, and the threads are called air threads, and sometimes these are seen floating over head, and sometimes they are borne down by the weight of the dew, and then caught on the bushes. Harry asked if Lucy ever saw the spider throw out or leave behind him these air threads?

She had not seen it herself, but she remembered, that one man in particular, who wrote about the flying spider, declared that he one day *saw* him throw out from his body this substance, and saw him afterwards mount and ride away upon it.

Exact Harry was preparing to question whether the flying spider flew, or crept, or rode, walked or darted upon the gossamer, or whether he moved of his own free will, or was blown, or borne away by the wind. But Lucy, too quick for his questions, hastened to tell him something more, that she had read of another insect, called the silk spider, who spins silk, which is almost as fine, some say finer, than that of the silk-worm. A pair of stockings were actu-

ally made of the spider-silk. They were presented, as Lucy assured him, to the French Academy of Sciences, and were much admired. Harry's attention became more respectful, when he heard of the Academy of Sciences.

"I was thinking," said he, "that great use might be made of all that gossamer, if it could be spun and woven."

"That has been thought of often," said Lucy; "people, at the time the stockings were made, hoped that the spider would do as well as the silk-worm; and they set the spiders at work in paper cases made on purpose, but after they had been kept many months spinning in their paper cells, their work was measured, and it was found, that nearly three hundred of the hardest working spiders cannot produce as much silk in the same time as one good active silk-worm."

Still Harry contended, that, since there are so many spiders, the great numbers might make up for the little they do; and as we have them always ready, how much

better it would be to set them properly to work, than to brush them and their cobwebs away, or to crush them to death.

To this Lucy replied, that the common house spider, who is, or ought to be, brushed away, is not the silk spinner; that the silk spinners were not as common as Harry imagined. "Besides, many faults," continued she, "are found with their way of working; they break their threads, or spin them only in short pieces, so that their silk cannot be wound, it can only be spun, and the reeling takes off its lustre. This want of lustre was complained of in the famous pair of spider-silk stockings, presented to the French Academy. On the contrary, the silk-worm spins her silk without breaking; she winds it round and round into cocoons, which can be easily unwound by a careful person. What length, Harry, do you think the silk-worm can spin without breaking?"

Harry was no judge of spinning; but since he must guess, he would say about

as long as the field over which the gossamer spread—perhaps about a quarter of a mile.

He did not think it possible, but he said it on purpose to guess something provokingly beyond what he supposed any silk-worm could do.

“A quarter of a mile!” repeated Lucy, “that is a good large guess; but you must know, that a silk-worm can spin without breaking as much as when unwound is six miles long! and, if she is not lazy, can do this in nine days! Believe it or not, Harry, as you please; but I assure you it is true. And what spider ever did as much?”

Harry looked as if he wished to urge something more in favour of the spiders, but had nothing else to say, except that still he did not doubt that some way would be invented of making them useful.

“Oh! my dear,” exclaimed Lucy, “I forget my very best argument; spiders can never work together, like good silk-worms, because they quarrel and fight,

and eat up one another. My insect book says, that, of I do not know how many, above forty or fifty, that were shut up together in one room, with plenty of flies and pith of quills, and all the delicacies they like, only two of them were, at the end of some days, found alive; and you know it would be impossible to give each of them a separate house; so there is an end of the matter."

"An end of the matter indeed!" said Harry; "I should never have thought of having any thing to do with them, if you had told me at first that they eat one another. Well, Lucy," continued Harry, "thanks to you and your insect books, we have had a great deal of diversion out of that field of gossamer."

"I feel much more pleasure in looking at things," said Lucy, "when I know something about them, even if it is ever so little."

"And then there is the hope of *the grand thing* that we are to see by and by,"

said Harry. "Papa, when do you think we shall see a steam engine?"

"Very soon, my dear," said his father. "We are now in Lancashire, where there are many manufactories, in which the machinery is worked by steam engines. I hope, that in the town in which we are to breakfast, I shall be able to show you the grand thing, as you call it, Harry."

"To day! this morning!" exclaimed Lucy.

Harry, in grave delight, rose from his seat to return his very best thanks; and, in an uncommonly emphatic tone, began with—

"I am *very* much obliged to you *indeed*, father."

But while he was pronouncing this in his sober manner, a branch of a tree under which they were going caught his hat, and carried it off. A little thing could make Lucy laugh before breakfast, when she was weak and hungry; and long after the hat had been regained and replaced,

and after the accident was forgotten by their father and mother, who were quietly reading, Lucy shook with unextinguishable laughter, even till they came in sight of the town where they were to breakfast.

After breakfast they walked with their father and mother through the town, to the place where they were to see a steam engine. A variety of objects caught Lucy's attention as they walked through the busy streets; but Harry was so intent upon what he expected to see at the end of his walk, that he did not look either to the right or the left as he passed.

Much as his expectations had been raised, he was not disappointed when he came to the reality. The ease and silence with which the huge beam of the steam engine moved up and down, struck him with admiration, and he stood for some time satisfied with watching its uniform motion. Next, he enjoyed the pleasure of recognizing each part of the great machinery that he had seen in the engrav-



ings which he had studied, and of which he had understood the descriptions.

Lucy could not immediately comprehend what she saw; she could not extend her ideas from the small scale of the engravings to the great size of the machine, which she now beheld. Another difficulty occurred: she could not at one view take in all the parts: she did not know where to look for the boiler and the cylinder, and all the innumerable small pipes puzzled her. However, with her father's assistance, she by degrees made out the principal parts, as they were seen in different stages of the building, for all could not be seen at once.

Good-natured Harry delayed to gratify his own curiosity till Lucy was quite clear in every thing she wished to understand: then he began to question his father. He wanted to know what work this steam-engine was doing. He heard some sounds, like the working of machinery, and he wished to see what was doing. The

guide, who had admitted them, now threw open a door, and they saw a very large apartment, full of whirling, whirling machinery, rows of spindles full of cotton, like the spindles of a spinning-wheel, standing upright in frames, which reached nearly across the room. Each spindle being supplied by a long line of untwisted cotton, from spools, or bobbins, above. Between each row stood a woman, or child, watching the work, and keeping the machinery clean.

"This is one of Arkwright's cotton mills," said the guide. "All this machinery is kept at work by this steam engine; and two other rooms full of cotton-frames, which you may see, if you please, above and below stairs."

Lucy uttered an exclamation of surprise. Harry was silent with admiration. Turning back towards the steam engine, he looked about to find where and how the motion was communicated from the engine to the spinning machinery. His

father, who guessed what he was looking for, showed him where the shaft was carried through the wall.

Harry had once seen a cotton manufactory, long ago; but he had only a confused remembrance of whirling spools, and noise, and dust. Here, as he observed, there was scarcely any dust, and but little noise. He was eager to examine and anxious to understand all he saw; but while he was watching them, the quick motion of the spinning spindles suddenly ceased, and, looking back to the steam engine, he saw the huge beam descending, with a soft, seemingly expiring motion.

“What is the matter?” cried Harry.

“Nothing, master,” answered the guide, smiling at his alarm. “Nothing, but that it is our dinner time. We stop the engine, and all the machines leave off working for an hour, till we come back and set the engine going again.”

“And is it possible, that the steam-

engine, and all these machines, can be stopped so soon and so easily?" cried Harry.

The man, pleased by the great interest which he saw that Harry felt, showed him how the whole was stopped, by closing the valves of the cylinder, and how the steam was let off, after the engine had been stopped.

The women and children were now clearing out of the large room, to go to their dinners, and in a few minutes the apartment was emptied of human creatures, and all was rest and silence. Harry looked blank. He was afraid that he should not see, hear, or learn any thing more; and he told Lucy, he thought it very unlucky that they had come at the workmen's hour of dinner. But, on the contrary, this proved a happy circumstance; for their father asked and obtained permission to stay during this quiet hour in the cotton mill, and he made use of this time to explain it, and to give them some account of the begin-

ning and progress of the invention, and of its improvement.

“ Probably all spinning,” said he, “ was originally done as it is now in the East, and in some of the southern parts of Europe, by holding in the left hand something like a distaff, with the material to be spun wrapped round it. With the right hand the spinner draws out the fibres of this material, whatever it may be, from the distaff, as in common spinning. It is twisted by a spool or spindle, hanging at the end of the thread, the spool being previously twirled by the finger and thumb. When the motion ceases or diminishes, so as not to be sufficient to twist the thread, what is spun is wound upon the spool, and the twirling is renewed. This is a simple but tedious mode of spinning. By degrees it was improved, and that ingenious contrivance, the spinning-wheel, such as that with which you are well acquainted, Lucy, was brought into use in England for spinning flax. For spinning wool, you know, a different sort of machine is used.”

“ Yes,” said Lucy, “ I recollect the large high wheel, with which I saw a woman spinning wool.”

“ Now let us go on to the spinning of cotton,” said her father, “ and the machinery for that purpose. To understand and follow the history of any invention, the first thing necessary is to have a clear idea of what is required to be done, and of the difficulties that are to be conquered. When cotton is taken out of the bale, or large parcel in which it is brought from the Indies, it is generally in hard lumps, sometimes stringy. To prepare it for carding, it is beaten with sticks to loosen it, otherwise it would break or spoil the teeth of the cards. It is then carded, the sole object of which is to separate all the fibres from each other: cards, something like those you have seen used in carding common wool, are employed for this purpose. The cotton is taken from the card in the form of a roll or *tail*, of about a foot long. Formerly, in the old way of spinning, the next operation was to attach the end of this roll

to a wooden spindle, placed horizontally, which could be turned round by a large wheel. The spinner gave the wheel a twirl, and immediately carrying back her hand, in which she held the other end of the roll, the cotton was lengthened, suppose from one foot to five — and at the same time it was twisted; the direction in which the hand moved had always a certain inclination to the spindle, so that the thread might slip off, over the end of the spindle, at every revolution. By this means it is twisted.”

“Yes,” said Lucy, “I understand this; I have seen it in spinning common wool.”

“Very well, this is called *long-wheel spinning*,” continued her father. “But it occurred to a poor weaver, of the name of Hargrave, that he could improve this method. As but little strength was employed in drawing out the cotton thread, or in turning the spindle which twisted it, he perceived, that if one woman had ten pair of hands and ten spindles, and could move them at once in the proper direction in

drawing out the cotton thread, she could spin ten times as much in the same time."

"Papa," interrupted Lucy, "If the woman had had a hundred spindles, and a hundred hands, like Briareus, she might have spun a hundred times as much."

"Not unless she had known how to use her hundred hands," said her father; "hands without head would do little. But now, without talking of Briareus, how do you think one head contrived to supply the place of many hands? Hargrave's difficulty was to hold fast and draw out many threads at once, keeping them separate, and pulling them evenly, while the spindles were twisting them. To accomplish this purpose he took two slips of wood, and cut their edges so that they could lie close together."

"Like the edges of a parallel ruler," said Lucy.

"Yes," said her father. "And between the edges of these he held fast the ends of the several rolls of cotton wool, which





were to be drawn out and twisted: the other ends of the rolls, of course, you know, were fastened on the spindles, one on each; and after they had been drawn out and twisted, the motion of the spindles continuing, the thread was wound round upon them. Now suppose the spindles to be set in motion, and that while they are turning he draws his ruler back, then you see each roll of cotton would be drawn out and twisted at once, as if each were spun by a separate hand."

"I see," said Lucy; "at least I understand."

"There are some contrivances necessary in doing this, of which I will not describe to you all the particulars, lest I should puzzle you," added her father.

"Thank you, papa," said Lucy. "But how did the man set the spindles in motion. You said, suppose they were turning, but you did not tell us how."

"He placed the spindles perpendicularly, side by side, in a row—eight, I think, he tried at first; and he set them in

motion by means of the large wheel, or *long wheel*, as they call it, which his wife used in spinning wool, so that they should all move at once. The wheel had a handle, which was turned by his wife, whilst the ruler, which held the cotton rovings, was drawn back, and they were, as he had expected, pulled out and twisted at the same time."

"How happy he must have been," cried Harry, "when he first saw it *do*! When he saw the eight threads drawn out, and the spindles spinning them all at once; How I should like to have been him at that instant!"

"I should have liked to have been in his wife's place at that instant," said Lucy.

"How happy she must have been, and his children, if they were standing by looking at it. So it succeeded perfectly?"

"Not so fast, Lucy, my dear; it succeeded for so much, but far from perfectly," said her father. "His first was but a very rude machine, and he had much difficulty in bringing it to a state fit for work."

ing. Then he advanced from eight to ten, twenty, eighty spindles, and he improved his machine so that it was brought into common use, and he called it a Spinning Jenny."

"A Spinning Jenny! Very right!" cried Lucy, "I suppose his wife's name was Jenny. I hope he made a great deal of money, poor man, to support his family."

"I wonder how he came first to think of this invention," said Harry.

"It is said," answered his father, "but I am not sure that it is true, that the first idea of it was suggested to Hargrave by an accident: a number of young people were one day assembled at his house, at the hour usually allotted for dinner. They were at play, and they by chance overturned the wheel at which Hargrave's wife was spinning wool. The thread remained in her hand, and the spindle was then perpendicular, and the wheel horizontal. The wheel being prevented, by the frame work, from touching the ground, it continued to turn round with the motion which had been

given to it, and kept the spindle in motion. Hargrave's attention was fixed upon it, and it is said that he uttered exclamations of delight, and again and again set the wheel in motion while it lay on the floor, and stood looking at it a long time, the bystanders thinking that he did so only from idleness."

"Aye, but he was not idle," said Harry; "he was at work, inventing, at that moment; but how did the overturning of the wheel help him?"

"Of that part of the story I am not clear," answered Harry's father. "It is said, that Hargrave had made attempts to spin with two spindles, with the common wheel for spinning wool, and that he had tried to use his left hand as well as his right, in drawing out the thread, but that he had always found this attempt ineffectual, on account of the horizontal position of the spindles; but when he observed them standing perpendicularly in the overturned wheel, he saw this difficulty obviated, and he thought of so placing his spindles."

"So then," cried Lucy, "his invention

was made by accident, by the lucky accident of the overturning that spinning wheel. How often and how many inventions are made by accident?"

"No," said her father; "inventions are never made by accident. To invent is to combine, or put things together for a particular purpose. This, which requires thought, cannot be done by mere chance; though accident may, and often does, suggest the first hint of an invention to an observing mind, or to a mind intent upon accomplishing a particular purpose, and discovers the means that may be used; as in this instance was the case with Hargrave. How many people have seen spinning wheels overturned, without ever inventing a spinning jenny. But now let me go on to tell you the next improvement that was made in cotton spinning."

"What! did not the spinning jennies do it all perfectly?" said Lucy.

"No, no, Lucy," said her father; "you must not be in such a hurry, we cannot come to perfection so soon. The spinning

jennies did only part of what was wanted. The cotton-thread spun by the jenny was found to be rough, spongy, and weak. It could be used only for the woof in weaving cotton, the warp could not be made of it. The warp was then made of linen-threads, which were strong and smooth."

"From what did this defect in the cotton spun by the spinning jenny arise?"

"From the fibres of the cotton not being laid smooth and parallel to each other, while it was drawn out and twisting. In spinning by hand, Lucy, you recollect seeing the spinner not only draw the thread out, but press and move it at the same time, between her finger and thumb. This smoothed the fibres of the cotton, and kept them parallel with each other. Now this was wanting in the spinning jenny. The motion of the hand in drawing out the thread was well imitated by the rulers or clasps, which, holding it fast when drawn back, answered the same purpose; but the motion of the spinner's finger and

thumb, and the effect produced by it, was to be supplied."

"How did Hargrave do that?" said Harry.

"He did not do it," answered Harry's father; "it was accomplished by another person, Mr. Arkwright, who, like Hargrave, was originally a poor and illiterate man, but who had the habit of observation and the power of invention."

"Well! how did Arkwright do it," said Harry, eagerly.

"By passing the cotton between rollers," said his father. "By passing it successively between three pair of rollers, placed near each other; the upper roller of each pair is pressed down with different weights. The first pair of rollers, through which the cotton is pressed and passed, turns slowly; the second faster, and the third more quickly, each with a steady motion. Now suppose, Harry, that the last pair of rollers moved eight times as fast as the first pair, then, eight times more length of cotton

would pass between that pair of rollers, than what had passed between the first pair, consequently the same quantity would be drawn out to eight times the length and eight times the fineness."

"Very ingenious," said Harry. "I wonder how Arkwright came to think of passing the cotton between rollers."

"It is said, Harry," replied his father, "that Arkwright had had frequent opportunities of seeing, in iron works, iron bars drawn out, by being passed between rollers, and he afterwards applied this idea to the drawing out of cotton."

"I am surprised he ever thought of it," said Harry; "because the fine fibres of cotton wool, and iron bars, are so different."

"Still there is some likeness," said Lucy, "in the motion of drawing out the thread thinner and thinner, and smoother and smoother. So you see, Harry, there is good sometimes in observing likenesses."

"What I have said," continued their father, "may give you some idea of the effect of the action of the rollers; I should



further tell you, that in the undermost of each pair of rollers were cut fine little grooves, or furrows, along the whole of its surface, to roughen it so as to prevent the cotton from slipping. The upper rollers were covered with leather. The passing the cotton *rovings* between these rollers, pressed together as I have described to you, with different weights, and moving with different velocities, had the same effect upon the cotton as that which is produced by the pressure and motion of the spinner's finger and thumb, smoothing down the loose fibres, laying and keeping them parallel with each other, and at the same time drawing them out so as to make a finer thread."

"So at last," said Lucy, "Arkwright did by the use of rollers what a woman did at first by the motion of her finger and thumb."

"Yes," said Harry; "but consider how much more was done in the same time, in one day perhaps, by the rollers, than a woman could do in her whole life spinning."

And how difficult, and how very ingenious it was, to imitate by machinery that motion of the finger and thumb. And this was Mr. Arkwright's great invention?"

"It was," said his father.

"But what became of the spinning jennies," said Harry; "were they laid aside when Arkwright made these improvements, and erected these mills?"

"The spinning jennies are very much laid aside, I believe," said his father, "in consequence of the defects which I mentioned. But for some purposes the cotton they spin is preferable, and for these the jennies are still used."

"Since Arkwright's time, have any great improvements been made, father," said Harry.

"No improvement has been made in the *principle* of his mode of spinning, but many in the simplicity and the perfecting of the machinery. The use of steam and steam engines, instead of water and water-wheels, for keeping these mills in motion, is in many places of great importance.

Of the various improvements in the detail of the machinery, I will only mention one to you, an invention made by a Mr. Samuel Crompton."

"That's right," said Harry. "I am glad papa always remembers and tells the name of the inventors."

"Mr. Crompton observed and joined together much that was essentially useful in Hargrave's spinning jenny, and in Arkwright's rollers, or *twist frame*; and he made a third machine, which combined many of the advantages of the former two, and which is preferred for spinning fine cotton, but is inferior in spinning coarse. This machine is called the *mule*."

"I should like to see the mule," said Harry.

"But you cannot see and understand every thing at once," said his father.

"I hear the workmen coming from dinner," said Lucy.

"Now we shall see this cotton-mill of Arkwright's at work," said Harry.

The guide coming in at this moment,

and hearing the last words Harry said, and the name of Arkwright, began to speak of the immense fortune which Sir Richard had made by his inventions and improvements.

“*Sir Richard!*” interrupted Harry, “how did he grow into Sir Richard?”

“The king conferred upon him the honour of knighthood,” answered the workman, and he went on speaking of the fine houses and estates Sir Richard Arkwright and his descendants have purchased.

“Did you ever hear, sir,” said he, “of the birth-day present which Sir Richard’s son made to each of his six sons. Each found on his table, on the morning of his birth-day, twenty thousand pounds.”

“Twenty thousand pounds! Six times twenty,” said Lucy: “that is one hundred and twenty thousand pounds! What a sum!”

“And all the consequence of one man’s invention,” said Harry.

“And industry and perseverance,” said his father. “Arkwright had great difficulties to struggle with, not only in per-

fecting his contrivance, but in reducing it to practice, and in establishing his right to the invention."

The workmen were by this time pouring into the room, men, women, and children, and the machinery was set a-going again in a minute or two, and all were busy. Even Lucy, as well as Harry, had some idea of what was doing. They knew the use of the spindles and of the cylinders. Without being perplexed by the smaller parts of the machinery, they had a complete view of each process that the cotton-wool undergoes, after it is taken out of its pod, till it is manufactured into the finest cotton.

As they were leaving one of the rooms, the guide showed them a heap of hanks or skeins of cotton yarn, all which, as he told them, had been spun by the mule from a single pound of fine cotton.

"There are here three hundred and fifty hanks," said he, "and each hank would measure eight hundred and forty yards; and the whole, if stretched out,

would make a thread one hundred and sixty-seven miles in length."

"One hundred and sixty ~~seven~~ miles!" repeated Lucy, "what would your flying spiders say to this, Harry?"

"Or your silk-worms, Lucy?" said Harry; "I think your ~~good~~ active best of silk-worms, never ~~spin~~ more than a silk the length of six miles."

"At any rate," said Lucy, "men and women beat spiders and silk-worms both in spinning."

Her father observed, that the proper object of comparison between rival spinners is, not the length of the thread, but the fineness. "And I apprehend," said he, "that either a silk-worm or spiders' thread, is as fine as one fibre of cotton wool; and the finest thread of cotton *must* be composed of many fibres." So that, notwithstanding Lucy's exultation in the superiority of men and women spinners over worms and spiders, Harry was compelled to give judgment in favour of the animals.

“But their superiority is owing only to instinct, and ours to ingenuity and reason, you know, Harry,” said Lucy. “It is no merit of theirs, that they have their materials prepared for them better than we have.”

Here the debate about the spiders and silk-worms was interrupted by the entrance of a gentleman, who was the principal proprietor of the cotton manufactory, and the conversation turned upon the prodigious sale of cotton goods and muslins in different parts of the world, especially in England.

“You are aware, madam,” said he, turning to Lucy’s mother, “that muslins were formerly all made in India; and that it is only thirty or forty years since we first attempted to make them in England, and not till within these few years that we have brought them to their present perfection.”

Lucy’s mother was well aware of this; she said she remembered, when she was a child, seeing some of the first muslin made

in England, and that it was coarse and rough, and looked ill, and wore ill ; and that no one then thought English could ever equal Indian muslins. But now it is difficult for the nicest eye to detect the difference in the appearance and in the wearing ; they are as good, if not better.

Harry's father turned to him, and whispered, " If you put me in mind, I will tell you some other time by what ingenious and bold contrivance that roughness in the first English muslin, of which your mother complained, was afterwards prevented."

The gentleman continued speaking, and when Harry heard his voice again he was telling of the immense quantity and value of the muslins now made in England and Scotland.

" All this we owe," said he, " to our using ingenious machinery, in these countries, instead of doing all by the labour of men's hands, as in India. Perhaps you are not yet aware, sir," said he, turning to Harry's father, " of the magnitude of the cotton manufacture. Its machinery



earns for England one thousand pounds every working hour. Forty thousand pounds weight of cotton wool is spun, and in three minutes the length of the thread spun would more than circumscribe the whole earth."

As this was said, they were passing through an apartment, where Lucy saw a machine for winding the pretty little balls of cotton—she wished to stay to look at it.

"Oh! papa, may I not look at this?"

But her father answered, "No, my dear, you have seen and heard enough—quite enough; if you were to see more you would confuse what I hope is now clear in your heads. Come away."

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IN the evening Lucy acknowledged that she was rather tired, and was glad to rest, and to stay with her mother, who did not wish to go out again. But Harry, boasting that he was as fresh as ever, was proud to be allowed to accompany his father, who was going to walk out to see the town.

After passing through several streets, they came to a broad public walk, on a high terrace, shaded with trees, from whence, looking back, they had a fine view of the town by the red light of the setting sun, which beautifully illuminated several windows, especially those of a Gothic church. As Harry was returning through the streets, he regretted that Lucy had not been with them, and he asked his father whether they were to go away from this town early in the morning, or if he would stay another day; his father, who, perhaps, was thinking of something else, answered, in an absent manner, "I do not know, my dear; that will depend upon circumstances."

Harry was considering, as he trudged on, what could be meant by "that will depend upon circumstances," when, on turning the corner of the street, his thoughts were stopped, and his eyes struck, with a sudden blaze of lights—gas lights. Harry's admiration lasted in silence the whole

length of the street; when turning into another, still more bright, he exclaimed,

“It is almost as light as day! Father, what kind of lights are these, and of what are they made?”

His father told him, that they were called gas lights, and that they were made of gas obtained from coal.

Harry asked, “How is gas different from other flame of candle or fire?”

His father told him, that *all* flame is gas set on fire. “In a common fire, in a candle, or lamp, what you see, and call flame, is gas, which, when set on fire, continues to flame when exposed to the air.”

Harry asked, “How is gas *got out of* coal?”

His father told him, “By the coal being strongly heated in iron vessels called retorts, which have but one opening for the gas to escape from into the reservoir where it is preserved.”

Harry next inquired how the gas gets from the reservoir to the small pipes, so

as to light all the houses in the street, where he saw gas flaming at the windows.

“ Suppose a tumbler to be inverted in a bason of water,” said his father, “ you know, that as there is air withinside of the tumbler, that air will prevent it from sinking in the water.”

“ Certainly,” said Harry.

“ But you may put weight upon the tumbler, till you compress the air in the inside, and then the water will first rise to supply the place of the compressed air. And what will happen afterwards, Harry ?”

“ I think nothing would happen, father, but that the water in the bason would continue pressing up the air till it had forced it into the smallest space possible.”

“ Very true, to the smallest space to which it is possible for the water to compress it; but the air being compressed, its elasticity continually increases, till it not only resists the pressure of the water, but drives out the water from the tumbler, and raises it in the surrounding bason. Now

suppose one end of a small pipe were introduced under the edge of the tumbler, what would happen?"

"The compressed air would be forced into the pipe to be sure," said Harry.

"And if the pipe were open at the other end?" said his father.

"The air would go out at the other end," said Harry.

"And what would happen to the tumbler?" said his father.

"The tumbler would continue descending till all the air was driven through the pipe," answered Harry.

"It would so. Now, instead of common air, suppose your tumbler filled with gas, exactly the same thing would take place. This is called a gas holder, and this is the manner in which the gas is continually forced from the reservoir through the pipes."

"I understand it," said Harry; "and I hope you will some time or other show this experiment to Lucy. It would be

very easily done with a glass and bason."

"You may show it to her yourself," said his father.

"Does the gas light immediately of itself, when it comes into the air?"

"No; when a person wants to light it he holds a candle to it, and it flames as you see in the open air."

"Suppose it was to rain, or suppose the wind blew strong," said Harry, "what would become of these lights? Look at these flaring, without any glass round them, in the open window, in this butcher's shop? Would not they be extinguished?"

"Not by slight rain or wind," said his father. "One great advantage of gas lights is, that they are not easily extinguished by rain or wind."

Harry's admiration increasing, the more he heard of their advantages, and considered their convenience, and beautiful brightness, he wondered why people had not thought of using them sooner. And

he asked if this gas had never been known to exist till now.

His father told him, that it had been long known as what we see in the flame of fire and candles; but that till lately no one had thought of obtaining it in quantities, and bringing it into common use, in the manner in which he now saw it. "I could tell you, Harry, two curious anecdotes, which I heard from a friend."

"Can you, father?" said Harry. "Then pray do. Will you be so good as to tell them to me now?"

"If you will mind where you are going, and not run into the gutter," said his father.

"About forty years ago, a certain Lord Dundonald had a patent for making what is called *coak* from coal. Coak is half-burnt coal, such as you have seen used in forges; to obtain the coak he half-burned the coal, and the tar and gas which were in the coal were, by this process, separated. The coak being his only object, the gas was conducted under water many hun-

dred yards, in large tunnels, in order to condense the tar, and the gas escaped out of a high chimney. How it became lighted my friend said he did not know; but once lighted, it continued to burn, and the flame illuminated the country for twenty miles round."

"I wish I had seen it," said Harry. "How grand and beautiful it must have looked! But when people saw this, I wonder no one thought directly of making use of the gas, and of obtaining it in the same way for lamps."

"It is the more surprising," said his father, "because it was, in fact, a gas apparatus, like that at present used, only the gas was suffered to escape and waste itself."

"But, father," said Harry, "what was the other anecdote?"

"Long before this Lord Dundonald's time, there was a chemist, whose name I do not recollect, who made gas from coal, and stored it in bladders, and frequently



amused his friends by pricking a hole in the bladder, and then applying a light to it. This was *portable* gas, such as people are now beginning to use, only in a different case."

"Well, this is more extraordinary still," said Harry; "because that gas in the bladder was in such a convenient form for carrying about; it is wonderful that neither he, nor any of his friends who saw it, ever thought of making use of it for lamps. I wish I had been by when he showed the bladder, and pricked it, and set fire to the gas. Father, even such a boy as I might have thought of it, might not I?"

"You might, Harry," said his father; "but how few men, to say nothing of boys, observe what they see any day, or every day, or think of what use can be made of it!"

"But so striking a thing! and so obvious a use!" said Harry. "What seems so easy and natural now, that it is done!"

"True, Harry. The thing was there

before their eyes, but useless, because they did not think of making use of it."

"And for forty years and more!" said Harry.

After a long silence, during which Harry stumbled sundry times, he exclaimed,

"Father! I am thinking—"

"Not of where you are going," said his father.

"But I am thinking, father, that there are a great many other little things, which people have not yet observed, that may lead to great things, if people think of putting them to use."

"Undoubtedly," said his father: "in this you are very right."

"And, father, do you think, that if I try to observe and consider what use I could put things to, I shall ever discover or invent any thing new?"

Harry was here interrupted by stumbling over a walking stick, with which a man whom they met was feeling his way, and which Harry had not observed.

"I wish that man would not poke out his stick so," said Harry; "it nearly threw me down."

The man begged his pardon—said he was blind, and was forced to grope his way with his stick. Harry now begged his pardon for running against his stick, and guided him across to the next street, and the old man wished him a good night, and said,

"May you never be blind as I am. And whenever you are old, may you meet with help as I have from you."

As soon as the blind man had left them, Harry began to recollect what he was saying when he first met him, and he would have resumed the conversation, but his father told him, that he could not talk to him any more now, and that he must walk fast, for it was getting late. Harry trudged on as quickly as he could. His father thought he must be tired, and so he was, but he scorned to complain.

It was late when they reached the inn. Tea had been waiting some time, and

Lucy, after struggling to keep herself awake, had fairly given up the point, and had fallen asleep, her head resting on her arms, which were crossed on the table. She was so fast asleep that she could hardly be wakened sufficiently when Harry came in, to ask whether he had had a pleasant walk. After swallowing a cup of tea, with her eyes half shut, she submissively obeyed the signal of the chambermaid with bed-chamber candles, and retired to that rest which she much wanted.

Harry would stay up to listen to a conversation between his father and a postilion, from which he hoped to discover what would be done in the morning, and what was meant by "that will depend upon circumstances." But before he had made this out he fell fast asleep across the great black trunk, where he lay unobserved, till the waiter tumbled over his legs, and let fall a spoon upon his head. Harry started up. He had dreamt, as he said, that he had been struck by the beam of a steam engine. His mother exhorted him

to go and dream in bed. She took up a candle to light him on his way; but he turned, and stood looking at the postillion, astonished to see him still standing there, and his father still talking to him.

"Mother! what an immense time this man has been standing talking," said Harry.

"Not above five minutes, my dear," replied his mother.

"Five minutes only!" cried Harry. "I have been in that time all the way to Germany, and back again, at a palace magnificently lighted up with flaming crocuses of gas. I asked whose house it was. 'Do not you know!' said the man. 'It is your friend the great Otto Guerick's.' I was not surprised that he was living still. I only said I would go and see him. But the inside of the palace was like a cotton-mill, and there was a great steam engine going on working away. Through all the workmen, and women, and children, I went on, asking for Otto Guerick, till at last one guide-man said he would show me the

way to Otto's laboratory, where he was trying experiments *always*, in his silk night-gown. But the man said the laboratory was at the top of the house, and asked if I could follow him up high ladders. Oh, yes! I said, as high as ever he pleased. So I went scrambling on after him, and if my foot had slipped, I should have gone down, down, down, I do not know where; but I reached the top, and a door opened, and I heard the rustling of Otto Guerick's silk night-gown, and I was just going in when that spoon, which I thought was the beam of a steam engine, fell upon my head. Oh, mother! I wish it had not fallen. It was so provoking to be wakened at that moment, just when I was going in to see Otto Guerick. I wish that I could dream it over again."

"You had best sleep again, Harry, my dear," said his mother, "and this time sleep in your bed. Come," said she, showing him the way through the passage to his bed-room, where she put into his hands his night-cap, which Lucy, even in

the depth of her own sleepiness, had remembered to leave ready for him.

Harry slept nine hours without intermission, but he saw no more of Otto Guerick, or his gas illuminated mansion. He was still fast asleep when his mother called him. During breakfast his father and mother talked about the various noises they had heard in this inn all night, and by which they had been so much disturbed that they could not sleep. His mother said, that a coach had arrived or set out every half hour, that she had heard bells and calls, hostlers and chambermaids, and waiters running to and fro in the passages continually, and people calling perpetually for their trunks, and portmanteaus, and parcels, and bills. Harry's father said, that the partition between their room and the next was so thin, that they could hear every sound; and there was a man in that room, who seemed to be pulling off his boots, and throwing them down, and throwing wooden legs after them all night.

Harry and Lucy looked at each other when their father and mother talked of all these noises; they were surprised, for they had slept so soundly, that they had not heard them.

During breakfast Harry told Lucy, that it depended upon circumstances whether they were to go on with their journey to-day, or to stay in this town. Lucy said she was not at all the wiser, as she did not know what circumstances he meant. Their mother told them, that it depended upon a letter which his father expected to receive by the post, to tell him whether his friend would return home this day or not. Harry's only reason for wishing to stay was, that Lucy might see the pretty walk he had taken the preceding evening, but as it was now raining, they could not walk, and he was glad that they were not to spend the day at the inn, where they had nothing to do.

"What shall we see next?" said Lucy, as she got into the carriage. "I like going on to something new."



"If you had your choice, Harry, what would you wish to see next?" said Lucy.

"A mountain," said Harry, who was faithful to his old wish for a mountain to measure with his portable barometer. While he had been taken up with the cotton manufactory, and the steam-engine, and the gas lights, this wish had slept in his mind; but it was now awakened with fresh eagerness. As they journeyed on he eyed the outline of every hill on the horizon. But he observed a discreet silence upon the subject. Even when Lucy exclaimed, "Here's a mountain coming for you, Harry!" he replied soberly — "So I see, my dear, but it is not near enough yet; I will speak when I think it is time."

At last, when they came into Derbyshire, and into the hilly parts of that county, Harry spoke, for he thought it was time.

"Father! here are plenty of mountains! will you be so good as to stop the carriage, and to let me get out, that I may measure this one which is almost close to us. I will

not detain you above twenty minutes, mother, if you could be so good as to wait — in ten minutes I would run up, in ten minutes I would be down again! May I, father?"

"No, Harry," said his father, "we cannot stop for you now. It would detain us much longer than you imagine. Your eye deceives you, in judging of distances, and of heights to which it is unaccustomed."

"For your comfort, Harry," added his mother, "we are going to Matlock, a place where you will find yourself surrounded by fine mountains, upon which you may try your own and your barometer's measuring powers at leisure, for we shall stay there two or three days."

"Delightful!" thought Harry, "Thank you mother," said he.

Presently they entered a narrow but beautiful valley, a stream ran through it, and there were hills on each side. Their banks were covered to a great height with trees of the softest foliage; and of various

shades of green, tinged here and there with the brown and yellow colours of autumn. Above, high above the young feathery plantations, and the scrubby brushwood, rose bare, whitish rocks. Sometimes stretching in perpendicular smooth masses; sometimes broken in abrupt craggy summits, huge fragments from which had fallen into the river below. The river flowed tranquil and placid till when opposed by these massy fragments, it foamed and frothed against their immoveable sides; then, separating, the waters whirled round them in different currents, and joining again, the stream ran on its course, sparkling in the sun-shine. The road now lying beside this river, brought them soon to the pretty straggling village of Matlock.

The morning after their arrival, they went out to walk. At a little distance from the hotel, where they lodged, was a walk up Masson-hill. It was a zigzag path, cut through a wood of fir trees, reaching to the summit, called the Heights of Abraham. They went part of the way up this path,

and Harry was eager to go to the very top, but his mother was not able, she said, to go quite to the Heights of Abraham; she, and his father, and Lucy, went to see a cave in this hill; but his father told Harry that he might go on by himself, if he liked it, to the top of Masson-hill, and take its height with his barometer, and compare this with the reputed height, which is said to be about 750 feet.

Harry, to Lucy's surprise, stood hesitating, with his barometer in his hand, instead of going on with the alacrity she expected.

"What is the matter? would you rather come with us to see the cave?" said Lucy.

"No," said Harry, "that is not the thing."

"What then?" said Lucy, "Do you want me to go with you; I should like it: but you know mamma said, that I must not go running about everywhere with you here, as I do at home; I must stay with mamma. But you look afraid to go by yourself," added Lucy, laughing.

"Afraid! my dear, I am not the least afraid to go by myself anywhere in the world," said Harry, proudly: "I am not going to do any thing wrong: what should I be afraid of?"

"I do not know," said Lucy, "that is what I want you to tell me. I am sure there is something you do not like, or else why do not you set off?"

"There is something I do not like," said Harry, "*that* I acknowledge. I do not like to meet those people who are there, farther up on the walk."

"What harm will they do you, Harry?" said his father.

"No harm, father; only I do not like to meet them, because they are strangers."

"But since, as you observed, Harry, you are not going to do any thing wrong, you need not be ashamed — I will not say *afraid*, to meet them!" said his mother.

"That is very true, mother," said Harry, "I know it is very foolish; well, I will conquer it; I will go on by myself," added he, resolutely.

“Go on and prosper then,” said his father. “I dare say that those people will never think about you, unless you do something to attract their attention.”

Harry walked off as fast as he could; nor stopped till he reached the Heights of Abraham. Then he took out his barometer, and noted down the height at which the mercury stood, both in the barometer and thermometer. Then he went down the hill, and, as soon as he had reached the bottom, he looked at the mercury again, in each, noting down carefully these heights also. Finding a retired nook, away from the public path, he sat down to work at his calculations, resolved not to stir till he had completed them. On his barometer there was engraved a table of the heights, at which the mercury stands at different elevations, calculated when the atmosphere is at the freezing point. Besides this, he had taken care to bring with him a certain little book\*

\* “An expeditious method of determining alti-

containing "An expeditious method of calculating altitudes;" the want of which had, in his first attempt to measure the church, prevented his succeeding to his satisfaction. Now understanding and following the directions contained in this little trusty companion to his dear portable barometer, he made his calculations sufficiently accurate to satisfy his conscience. He brought his answer within two feet of the height, which his father had told him had been determined by previous measurement.

He next went to look for the cave.

It was a large, deep, dark cavern, at the farther end of which he perceived light; and as he advanced he saw the forms of men — of the guides, who held torches, and he heard Lucy's voice, and the voices of his father and mother, and soon distin-

tudes with the new portable mountain barometer; with a description of that instrument, by Sir Harry Englefield, Bart."

A little tract, which is, or ought to be, sold with every portable barometer.

guished their figures. They were all looking up at the roof, on which the guides, with raised torches, threw a strong light. From the roof, which appeared encrusted all over with yellow earth, hung multitudes of what seemed like earthy icicles, of the same colour, and of enormous bulk.

"My dear Harry! are you there?" cried Lucy, "I am glad you are come; I was so afraid you would not come in time to see these! Are not they beautiful? Do you know what they are? They are stalactites."

"And how came they there?" said Harry, "and what are they? You tell me they are *stalactites*, but that tells me nothing but their name."

"It is a good thing in the first place," said Lucy, "to know the name, because then we can ask people questions, and then they will know what we are talking about." She told him all she had just learned, from what she had heard the guides and her father say; that these



stalactites were formed by the water oozing through the roof of the cavern, and depositing, as it trickled down, some calcareous earth, which it had dissolved in its course through the soil and rocks, along and down which it had passed. She believed that these rocks were calcareous, or limestone. She had further heard one of the guides say, that some stalactites found in this country became almost as hard as stones, were of various colours, and had been polished and made into necklaces, and different ornaments. The guides had broken off from the sides of the cave some of the stalactites, and had given pieces of them to Lucy; some of these, which had been newly formed, were softish, and crumbled easily when pressed between the fingers; some were a little harder and crisp, cracking rather than mouldering when pressed; others were as hard, Harry observed, as some petrifications which he had seen in his uncle's collection. His father told him, that those petrifications had been formed

in the same manner in which these stalactites were formed ; and the guides said that they would show him plenty of petrifications ; and crystals, and beautiful spars of different colours, for which Derbyshire is famous.

While all this was saying, Lucy's mother, who did not like standing still long in this damp cavern, had by gentle degrees, alternately drawing Lucy on by the hand, and urging Harry forward by the shoulder, kept moving onwards, till they found themselves again at the entrance or the exit of the cave ; they were glad to see the day-light, to feel the fresh warm air, and to tread again on dry ground.

Several boys and girls met them in their way to the hotel, with baskets of crystals, spars, and petrifications. In one basket Lucy saw a petrified wig. The guides told her, that the people of Matlock amuse themselves by putting wigs and different things in these calcareous springs, to have them, as they say,

*converted* into stone. Such they seem to turn into, as no appearance of the original substance is left except the form. But, as Harry observed, it is not that the substance turns into stone, but that the calcareous deposition covers it all over, and the original substance in time decaying, nothing afterwards is left but calcareous stone. In another basket Lucy saw spars of various colours; some of purple and some of amber, of different shades, in rainbow stripes, or cloud-like streaks. Some of these spars were made into hearts, and necklaces, and boxes, and urns, and eggs, and various trinkets.

Lucy's mother told her that she might choose any one of these things she liked.

Lucy chose a polished egg, of shaded purple spar; it seemed transparent, and looked as if you could see into it to a great depth, but when Lucy tried to open it, she found that it did not open.

"Of what use then can it be?"

It had a little gold ring at the top of it, and was intended to be used as a netting

weight. Lucy had been long making a purse for her father: she was sure that the pleasure of using this pretty weight would encourage her to go on netting it, as soon as ever they should come to the end of their journey. But how was the egg to be carried? Her father said he could not have it rolling about the carriage; and the pockets were already fully occupied. Lucy would have been reduced to take a flat heart, instead of her beautiful egg, if Harry—"good at need"—had not stepped forward, and opening, wide as he could stretch, the mouth of his waistcoat pocket, bid her put her egg in there, "where there is plenty and plenty of room," added he, shrinking in his stomach to show the ample space.

"My dear Harry, you are very good," said Lucy.

"Not the least," said Harry; "I should be very bad, if I did not recollect how good you were about my camera obscura, which you crammed into the

trunk. Come, drop your egg in here at once, and say no more about it."

She dropped it into the pocket.

"But, my dear Harry, it looks as if you had a great swelling; people will stare."

"I do not care," said Harry; "let them stare."

This was indeed, as Lucy knew, a great proof of Harry's affection; for in general he disliked excessively to be stared at, and avoided every thing that could bring upon him such a misfortune.

"Besides," added he, patting down the egg in his pocket, "it does not stick out *now* more than my ball, which I have often carried here, and nobody ever noticed it, except my mother. Indeed, now I have got it into the corner, you see it is not a greater lump than my pocket handkerchief, which sticks out as much on the other side, so all's right."

"But if you were to tumble down, the hard egg might hurt you, Harry."

"I might hurt it," said Harry, "for I

should break it, I suppose. But, my dear, I never, that is hardly ever, tumble down ; and now I have this egg, it will make me more careful ; so say no more about it. Now I want to tell you about the Heights of Abraham."

He had prudently forborne to speak of his operations, while her head had been full of stalactites, and spars, and wigs. She now listened to him with due sympathy, and was delighted when he informed her, that his barometer measurement came right within two feet. His father congratulated him upon his success, with which he was particularly pleased, because it was the consequence of perseverance. He was glad to see that his son would not be satisfied till he had rectified his errors, and had been as exact as he possibly could. This promised well for his future progress. All the rest was mere child's play. "Very few uncles," said he, "would have given a portable barometer to a boy of your age. I am glad you can prove to him that you

have been able to use his present, and that it has been of service to you, Harry."

"It was lucky for me," said Harry, "that there was nobody by, on those Heights of Abraham, when I was at my work; and lucky too, when I came to the bottom of the hill, that I found a snug place, out of the way of every body, where I made my calculations, or else I am sure they would have been all wrong."

"That would have been a pity!" said Lucy, "after all your pains."

"Therefore it would be a great advantage to you, Harry," said his father, "if you could learn to calculate, and to be able to go on with whatever you are doing, when people are looking at you, as well as when you are by yourself; because you cannot hope always to be alone when you want to think, nor can you always hope to find snug solitary places for your calculations. Every common schoolboy is forced to learn his lesson, and to cast up sums without being

disturbed by strangers. All this is easily learned by practice."

"Aye, by practice, I dare say," said Harry.

"And I will tell you what you can do by your own sense," added his father: "upon every opportunity try to conquer your dislike to going among strangers, and then you will get over your bashfulness."

"Father, then, if you please, I will go with you to day, and dine at the public table, instead of staying with my mother and Lucy."

"Right, my boy, so you shall."

When dinner time came, Harry went along with his father, and, as he walked into the public room, said to himself, "I am doing nothing wrong: I need not be ashamed: I will not be bashful." Still a mist of confusion came before his eyes, when, seated beside his father, at a very long table, he saw opposite to him a line of strangers, and on all sides of him strangers! He scarcely ventured to look up at their faces. He was seized



with one of his fits of the cramp of bashfulness, under which he sat suffering and stiffened, blushing, and conscious that he was blushing, scarcely able to answer "Yes," or, "No, thank you," when he was asked what he would have. He thought that every body must take him for a fool, and this made him feel more uneasy and awkward. He scarcely saw, or knew, what he was doing; he threw down first one thing, then another; first his fork, then his bread in reaching for the fork, then the salt cellar, and at last a glass of water into his father's plate. It was well it was no worse. His father set the glass up again, sent away his plate, and said nothing about it. Harry wished he was in his mother's room, or under the table, or anywhere but where he was. His blunders and disasters had more and more provoked him with himself, and he thought he had disgraced himself for ever, and that people must think he was a vulgar creature, or a child not fit to dine with men or gentlemen, nor used to dine any-

where but in the nursery. His face was by this time all burning with shame, and scarlet up to the roots of his hair.

While he was in this condition, the lady who was sitting beside him, asked him if she should help him to some oysters: he happened to dislike oysters, and he answered, "No, thank you," in rather a surly tone; and then, thinking he had done wrong to answer so gruffly, held his plate out, and said, "If you please, ma'am."

"But you have not finished your sweetmeat; I did not observe that," said the lady. "You do not like sweetmeats and oysters together, do you, my dear?"

"I do not care, ma'am, thank you," said Harry.

"You are not the young gentleman, are you," said the lady, "whom I met this morning, with a barometer in his hand?"

"I do not remember meeting you, ma'am," said Harry; "but I had a barometer in my hand."

"Really: I should not have thought you

were the same. May I ask what you were doing with that barometer?"

"I cannot explain it to you, ma'am, now," said Harry.

A gentleman luckily asked her at this moment to drink a glass of wine, and she turned away from Harry, and thought no more about him or her question. Still his father took no notice of him, but left him to recover himself by degrees, and to find out the truth, that people were thinking of themselves much more than of him. Gradually he came to the use of his senses and understanding, so far as to hear and comprehend something entertaining, which a gentleman who sat opposite was relating. As soon as Harry became interested in listening to what this gentleman was saying, he unstiffened, looked up, moved forward on his chair, forgot his blushes and his blunders, and all his fears of having disgraced himself; in short, he forgot *himself* altogether.

The gentleman was giving an account of the plundering of a vessel, which had

been stranded on the coast of South Wales, in St. Bride's bay. It was a transport laden with ordnance stores from America.

Harry made out, that "ordnance stores" here meant gunpowder and guns. Some of the people on the coast saw the signals of distress, which were made by the persons on board the vessel; but instead of putting out boats, and going to their assistance, these wicked people thought only of plundering the vessel, and carrying away every thing they could for themselves. They assembled on the beach, and waited there till the ship was driven on shore, and wrecked. While the poor people on board were trying to save their lives, these plunderers were busy carrying off all they could from the wreck. They boarded her as soon as possible, because they knew, that as soon as ever the gentlemen of the country should hear that a vessel had been wrecked, they would come to assist the sufferers, and to prevent the plunder. The mob made such haste, that they got possession of their prey, and landed a con-

siderable quantity of gunpowder from the stranded vessel. Many of the plunderers were loaded with as much as they could carry, while others were struggling for their share of the booty, as their confederates were dragging it on the shore.

In this scene of confusion, and in these struggles, a quantity of the gunpowder was scattered on the shore, and on the rocks. One of the ringleaders of the mob quarrelling with another, who had got possession of a musket, which he wanted to have for himself, seized it and threw it from him with violence. What happened none could exactly see, as it all passed so quickly; but, probably, the musket had struck against a flint—a single spark was enough set fire to the gunpowder which was scattered over the rock. One explosion after another was heard, one train communicated to another, and in a few seconds the whole strand and rocks seemed wrapped in fire and smoke. Many of the plunderers were killed on the spot; others were dreadfully maimed, and died

lingering deaths. The man who threw the musket absconded, and was never heard of afterwards."

While Harry listened to this dreadful but true story, pity for the shipwrecked people who perished for want of timely assistance, indignation against the wretches who thought only of plundering the wreck, wretches such as he could hardly believe to exist, horror at the catastrophe, an awful sense of the justice of the punishment which they immediately brought upon themselves, and satisfaction that they gained nothing by their crime — altogether filled his mind; and these successive sentiments and reflections so absorbed him, that he completely forgot every thing else, forgot where he was, and who was by, and all his own little foolish feelings. What was become of his bashfulness? It was all gone? gone off with that superfluous anxiety, which he had felt about the opinions the surrounding people might form of him.

AFTER they left Matlock, the road appeared uninteresting to our travellers. But they had books in the carriage, and Lucy's mother began to read at first to herself, and afterwards to her companions, when she found any thing that she thought would entertain them.

"Here is an account," said she, "of the various stinging insects which infest parts of South America; where the inhabitants pass their lives complaining of the insufferable torment of the moschettoes.

"Will you be so good as to read it to us now?" said Lucy; "I am so very comfortably settled, with your dressing box under my feet."

"Persons who have not navigated the great rivers of South America, for instance the Oroonoko and the Rio Magdalena, can scarcely conceive how, at every instant of life, you may be tormented by insects flying in the air, and how the multitude of these little animals may render vast re-

gions almost uninhabitable. They cover your face and hands, pierce clothes with their long sucker, in the form of a needle, get into your mouth and nostrils, and set you coughing and sneezing whenever you attempt to speak in the open air. In the villages, on the banks of the Oroonoko, which are surrounded by immense forests, the plague of flies affords an inexhaustible subject of conversation. When two persons meet in the morning, the first questions they address to each other are, "How did you find the *zancudo*s during the night? How are we to-day as to *moschettoes*\*."

At New Barcelona, the wretched inhabitants generally stretch themselves on the ground, and pass the night buried in sand, three or four inches deep, leaving out their heads only, which they cover with handkerchiefs. Farther on, the traveller fares worse, for he comes to the region of the *sorrowful people*, as they are called, who are doomed to be for ever tortured by these in-

\* Humboldt. Personal Narrative, vol v.



sects. One poor monk, who had spent, as he said, his twenty years of moschettoes, in that country, desired Humboldt and his companions to tell the people in Europe, what the poor monks suffer in the forests of South America. When an inferior monk commits any fault, his superior exiles him to this country, and they call it being condemned to the moschettoes.

Lucy said she was glad she was not condemned to the moschettoes, and she asked her mother if there was any more that was entertaining about them. Her mother read to her an account of the different kinds of stinging insects, which *maint guard* at different hours of the day and night. Just at the time, when one party are flying away, and when the next have not fixed, or, as soldiers would say, at the time of *relieving guard*, there is an interval of repose. The different hours of the day and night are marked and known to the inhabitants by the different stinging flies, so that, as they say, they could tell blindfold

what hour it is, by the sting of the last, or the hum of the coming torment.

"Horrible creatures!" said Lucy, "I am very glad we have none of them in our country."

"Horrible!" repeated Harry, in an absent tone: he seemed to be heartily glad to have this history of the moschettoes finished, and to get rid of them. They had prevented him from fixing his attention upon something which he wanted to think of.

The moment his mother's closing tone announced that she had finished, he threw himself half over his side of the carriage, and began to watch the hind wheel.

"Is there any thing the matter with the wheel, brother?" said Lucy.

"Nothing, my dear, I am only thinking of something."

"Take care, Harry," said his mother, "I think you will fall out."

"No thank you, mamma, there is no danger of that, I am holding by the holders," said Harry.

There was nothing more to be said about the safety of the position he had chosen ; something might, perhaps, have been said about its unsociability, but his mother went on reading, and his father and Lucy were listening to her.

“ Oh ! Harry ! ” cried Lucy, “ listen to this, here are the termites, the great ants, will not you hear about them ? ”

“ Thank you, ” said Harry, “ I have heard enough about them. ”

She left him to his wheel for some time, but presently returned again with —

“ Oh ! Harry, did you hear that about the jaguar ? that came bounding to the shore to play with the little girl, and tore the skin of her forehead, and she drove him away with the bough of a tree ; only think ! — the jaguar ! ”

“ My dear Lucy, you jogged me and put me out in my count. Now I must begin all over again, ” said Harry.

She drew back, but after some little time exclaimed again —

“ Harry ! Oh ! Harry, hear this ! a *shirt*

*tree!* My dear Harry, a real name of a real tree, fifty feet high, shirts ready made grow upon them without a seam!

“One hundred and fifty-five: I am very glad of it. One hundred and fifty-seven,” said Harry, continuing to count on.

“If the shirt-tree won’t do, nothing will,” thought Lucy; and she sat down and sat still during many pages; then starting up again, she threw her arm round him.

“Oh! Harry, Harry; the most beautiful story you ever heard. A mother in search of her children, who went through such difficulties, and such places, as no person had ever the courage to go through before! and lived for four days on nothing but black ants, and was stretched upon the rack at last, and tortured. Oh! Harry, won’t you listen to the end of it?”

“Two hundred and twenty-one: my dear, another time, you will tell it to me; two hundred and twenty-two.”

Lucy gave it up, left him to himself, and listened to the end of the story; sorry,

however, that he could not; or would not enjoy the pleasure with her.

After this story of the Piedra del la Madre, a rock of the mother, was finished, Lucy's mother was tired reading aloud: he father took up a book to read to himself; and Lucy, who had the happy power, either travelling or at home, of being able to amuse herself, began to point out to her mother every thing or animal she saw on the road, which she thought would look pretty in drawing.

"Look, mamma, at that woman, who is crossing the field with a basket of hay on her back, and the cow following, without her perceiving it, and eating the hay, is it not like one of the vignettes in Bewick? Mamma, as you are not busy now, whenever I see what I think would be a good Bewick on the road, I will tell you, and you will tell me whether you think it would be pretty or not."

"Look at this old tired soldier stopping beside the well, and the little girl holding

up a tin can that she has just filled. Now he is stooping to drink, and she is putting back her hair off her forehead, and the setting sun full on her face. Would not this be a pretty Bewick?"

Her father, who had now finished what he was reading, and who was always cheerful and sociable, put away his book, and looked out of the window, joining with Lucy and her mother in their diversion. Presently he saw an old man and woman trudging together down a lane that led to a wood, and he began to sing a favourite song of Lucy's, in which she immediately joined :

“ There was an old man who lived in a wood  
As you may plainly see,  
He said he could do more work in a day  
Than his wife could do in three.

“ With all my heart, the old woman said,  
If you will me allow,  
You shall stay at home to day,  
And I'll go follow the plough.”

Harry turned about, and looked much discomfited by the singing, and Lucy said :—

“ Join us Harry, oh ! join us, you know it.”

But Harry replied only by stopping both his ears, and hanging again out of the carriage window further than before. The singing in full glee was continuing, when Harry drew in his head, and rubbing his hands, exclaimed, as he threw himself back in his corner—

“ I have it ! I have found it out, papa !”

His father did not ask what he had found out, but went on singing.

“ Father,” said Harry, “ will you explain to me now what is meant by a patent, or by taking out a patent for an invention ?”

“ I am singing, do not you hear ?” said his father. “ Go on Lucy, go on singing with me.”

When they had finished the song, Harry asked his question again, about the patent

for an invention, but his father did not listen to him.

"Papa," cried Harry, after eagerly waiting for the moment, when as he thought he could fix his attention; "I want to tell you what I have been thinking of all this time."

"I do not want to hear it, Harry," said his father, "I cannot turn my mind to what you are thinking of; I will go on with my own thoughts."

So saying, his father put himself into Harry's late position, hanging over the side of the carriage.

"Well," said he, at last, turning to Harry, who looked doleful, "you feel how unpleasant it is, not to have people ready to sympathize with you; you feel how disagreeable it would be to you, if we could not turn our thoughts to what you are thinking of, when you wish for our attention."

Harry, looking ashamed, said, "That is true, papa, I believe I have been all day



very disagreeable ; but I did not mean it ; I was thinking of something that I hoped you would be pleased with, and I did not like to leave off till I had quite invented it, or at least made it as good as I could."

" Oh ! papa," said Lucy, " may I speak ? You ought to be pleased with his going on persevering through all the noises we made, and every interruption. I am sure I could not so have fixed my attention."

" You and your brother, my dear Lucy," said her father, " have two opposite faults, and I wish you both to know them, that you may take care and use your power over your own minds to cure them. Your attention, Lucy, passes too quickly from one thing to another. You are what is vulgarly called birdwitted. You should endeavour to prevent your mind from flying off from one subject to another : I encourage you to fix it as steadily, and as long at a time as you can. You are of such an affectionate, sympathizing temper, that there is no danger that you should

not be ready enough to turn your thoughts to the pursuits and amusements of others, whenever it is necessary or agreeable. You, Harry, have acquired the power and habit of fixing your attention steadily on your own pursuits, but you cannot easily turn your mind from your own thoughts to what is going on near you, or to what other people wish you to think of. Now consider, that your sister, and your mother, and I, and every body, like sympathy, as well as you do probably; and if you acquired this unsociable habit of never joining in what we are doing, or being interested in what we are saying or hearing, you would become a very disagreeable companion."

"I hope I shall not," said Harry, with a look of serious alarm.

"You have perseverance and laudable ambition enough," continued his father; "but the danger for you is, that you should confine your attention too much to one small circle of objects, and not enlarge your mind by general observation and knowledge.

You perceive, that I speak to you, not as to a foolish child, but as to a reasonable creature, who is desirous to improve himself. On this journey you will have opportunities of curing yourself of this fault. When you are going through a new country, look about you, observe every thing. When you are with people who are talking on subjects that are new to you, listen to what they say. Much knowledge and amusement can be gained by the ear as well as by the eye. 'Ears and no ears' might make a good tale as well as 'Eyes and no eyes.'"

"He did listen the other day, papa," said Lucy, "and heard what the gentleman told about the wreck and the gunpowder: Harry repeated it to me afterwards."

"As he was so well rewarded by hearing what was entertaining, and by your remembering it so kindly," said her father, "I hope he will continue to attend to conversation."

"If people did not talk so much non-

sense generally, in company, sir," said Harry, "I should listen oftener."

"Pick out the sense: if you try to do so, you will always find some golden grains of sense even in an ocean of nonsense. And suppose you should not, it will be of use to your own mind to interrupt, even by nonsense, the course of your thoughts. The mind becomes stupified, when it has thought too long on any one point."

"True," said Harry, "so I found to-day, when I was thinking about my measuring wheel. When I had thought and thought for a great while, I grew quite tired and stupid, I could not tell what was the matter with me; I could not invent what I wanted; and listening even to the moschettoes, which I hated at the time, did me good."

"Harry is so candid," said his mother, "that there is really some pleasure in finding fault with him."

He was not like those foolish boys, who, when they are told of any fault, think only

how soon the person who is speaking will have done, that they may get rid of the immediate pain. Nor was he one of those, who think only of what excuse they can make. Nor yet was he one of those (the most foolish) who grow sulky, and sit or stand like statues, feeling all the time as if the nightmare prevented them from stirring. It is true that Harry was acquainted with this disagreeable sensation, arising partly from shame, and partly from pride; but he struggled against it, and threw it off as soon as possible.

"Lucy, what were you doing before all this began?" asked Harry.

"We were singing the 'Old Man in the Wood,'" said Lucy; and then she added, in a whisper, "should you like to sing it again? if you would, I will begin it."

"I should," said he, "begin."

She began, Harry followed, and their father immediately joined them. They sung but badly, but they were all well

pleased with each other, and Lucy said she was now *quite* happy.

“ There must be some *nonsense* mixed with wisdom now and then, must not there, papa ?” said she, “ or else one is apt to grow terribly tired.”

END OF VOL. I.

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